OPERATING MANUAL

T-BERD 209

T-CARRIER ANALYZER

MP MASTER

MA30842

Telecommunications Techniques Corporation

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IMPORTANT

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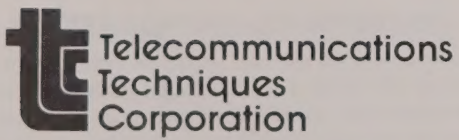
T-BERD 209
T-CARRIER ANALYZER
OPERATING MANUAL

SEPTEMBER 1987



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MANUAL ABSTRACT

The T-BERD 209 T-Carrier Analyzer Operating Manual contains eight sections and two appendices. Each manual section is briefly described below.

SECTION 1 GENERAL INFORMATION

This section defines the scope of the operating manual and presents an overview of the T-BERD 209 and its capabilities.

SECTION 2 FUNCTIONAL DESCRIPTION

This section describes the T-BERD 209's various measurement capabilities as well as its front and side panel switches, indicators, displays, and connectors.

SECTION 3 PREPARATION FOR USE

Provided in this section are both information on unpacking and inspecting the instrument and an instrument checkout procedure.

SECTION 4 OPERATION

This section contains step-by-step procedures for (1) in-service and out-of-service testing of T1, SLC*-96, and T1C lines; (2) simplex current measurement and CSU emulation; (3) signal level measurement; and (4) timing slips measurement.

SECTION 5 PRINTER/CONTROLLER INTERFACES

This section describes the printer interface and printer/remote control interface options that are available for use with the T-BERD 209; it also discusses their operation for printing, remote control, and timing slips measurements purposes. This section includes an alphabetical list of remote control commands with command entry examples.

SECTION 6 MAINTENANCE AND SERVICE

This section contains information on routine maintenance as well as TTC's warranty and equipment return policies.

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SECTION 7 SPECIFICATIONS

This section contains the specifications for the T-BERD 209.

SECTION 8 OPTIONS AND ACCESSORIES

This section describes the options and some of the accessories available for use with the T-BERD 209.

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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual is issued to provide information on the physical and functional features, operation, and specifications of Telecommunications Techniques Corporation's T-BERD 209 T-Carrier Analyzer.

1.2 INSTRUMENT OVERVIEW

The T-BERD 209 T-Carrier Analyzer is a portable test set designed for use during routine maintenance, installation, acceptance testing, and fault isolation of T1 and T1C transmission systems. Rugged, yet lightweight, the T-BERD 209 is packaged in a drawn aluminum case that allows storage for a power cord and accessory cables. Removing the T-BERD 209's cover reveals a front control panel that consists of a combination of multi-position rocker switches with adjacent LED indicators, color-coded alarm and status indicators, and a vacuum fluourescent display.

The T-BERD 209 is eminently suited for both central office and customer premise testing. In the central office, the T-BERD 209 may be used to generate and receive test patterns for out-of-service monitoring as well as to monitor T1 or T1C circuits without service interruption. At the customer premise, the instrument may be used to detect and isolate both customer-owned equipment problems and problems emanating from the span line; the T-BERD 209 may also be used to perform the tests required for initial circuit installation. With the T-BERD 209, no CSU is required for span line testing.

The T-BERD 209 features simplex current, signal level, timing slip, and recovered clock frequency measurements. Line buildout is selectable, and loopback codes are both generated and detected. The T-BERD 209 operates with D4, ESF (Extended Superframe), and SLC-96 framing patterns and is DACS (Digital Access Crossconnect Switches) compatible. An unframed mode permits compatibility with traditional KS-type test sets. Error measurements include logic, bipolar, and frame errors as well as associated error rate, errored second, and percent error-free seconds calculations. Signal loss and alarm conditions are continuously displayed, and a record of alarm conditions is maintained. An optional performance analysis package (per CCITT Recommendation G.821) provides severely errored second, degraded minute, unavailability, and availability measurements. An optional printer interface allows all test results to be output to a standard RS-232 printer, an optional printer remote control interface additionally provides remote testing capabilities.

SECTION 2
FUNCTIONAL DESCRIPTION

2.1 INTRODUCTION

This section describes the T-BERD 209 T-Carrier Analyzer's various measurement capabilities. Also included are descriptions of the T-BERD 209's front panel switches, indicators, displays, and connectors; its side panel DIP switches and connectors; and the built-in reference card.

2.2 OPERATING MODES

The T-BERD 209 provides in-depth testing capabilities for T1 and T1C circuits. T1 modes include: (1) Unframed, for compatibility with existing test equipment on circuits where framing is not required; (2) Framed, for testing circuits which include multiplexers and Digital Access and Crossconnect Switches through which only framed data will pass; and (3) Test Loopback and Line Loopback, which simulate a CSU's loopback features and are useful when installing or troubleshooting T1 spans. T1 framing modes include D4, ESF, and SLC-96 data formats. There are two T1C modes, T1C and T1C TLB, which can be used for T1C link testing. An Auxiliary mode allows operating parameters to be set for which dedicated switches are not provided. A self-test mode is also provided.

2.3 FRONT PANEL SWITCHES, INDICATORS, AND CONNECTORS

The T-BERD 209 is operated through a variety of switches on its front panel and on the right side panel. The front panel features a combination of multi-position rocker switches, pushbutton switches, and LED indicators. Most of the multi-position switches feature adjacent LED indicators which are illuminated to indicate the current setting of the switch, and several of the pushbutton switches contain LED indicators within the switches that are illuminated under certain conditions. All of these features are described in subsequent paragraphs.

2.3.1 Switches

The following list describes the T-BERD 209's front panel switches. The numbers in the list correspond to the numbers in Figure 2-1.

(1) **MODE**—This switch controls the transmit and receive line rate and data format for the T-BERD 209. Pressing the MODE switch allows the user to scroll through a list of ten available modes; this list appears on the top line of the display immediately above the switch.

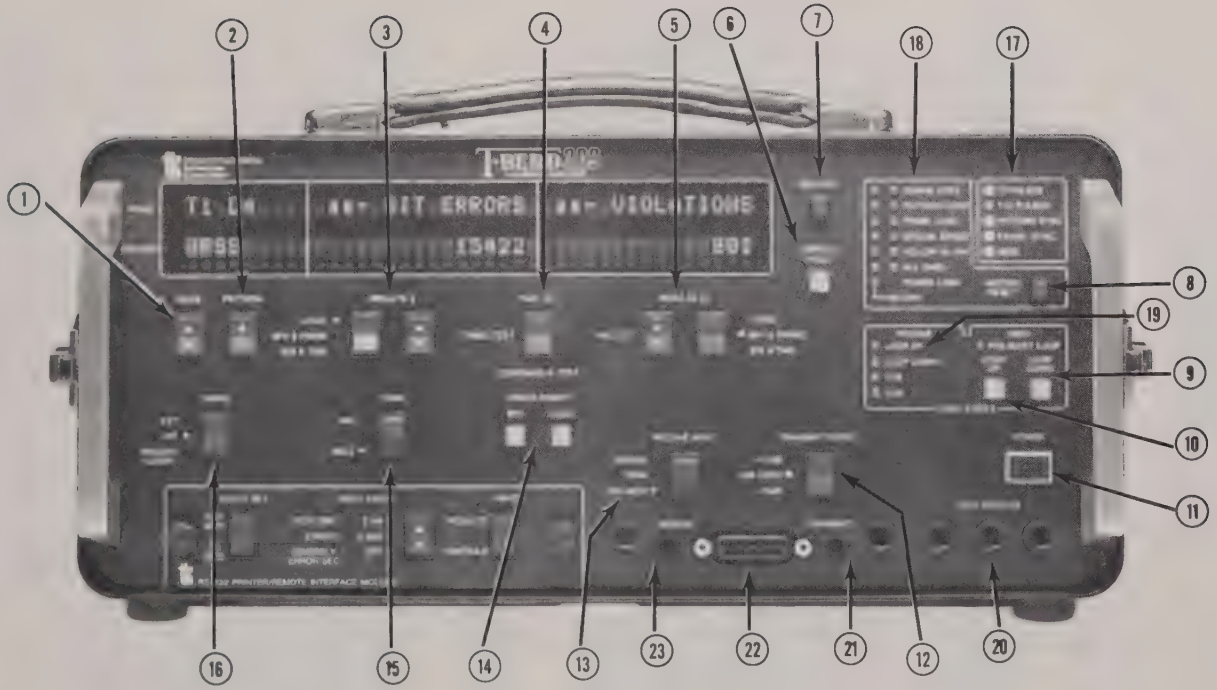


Figure 2-1

T-BERD 209 Front Panel

Releasing the MODE switch causes selection of the mode currently displayed. Changing MODE selections causes a test restart. The available modes are described below.

(a) T1—This mode allows T1 data to be transmitted using an unframed data format.

(b) T1C—This mode allows T1C data to be transmitted using an unframed data format.

(c) T1 D4, T1 SLC, T1 ESF—These modes allow T1 data to be transmitted using a framed data format. The T1 D4 and T1 ESF modes are used for D4 framing and ESF (Fe) framing, respectively. The T1 SLC mode is used to monitor T1 lines which use the SLC-96 data format. This is done by ignoring the framing bits that are used as a data link. In T1 SLC mode, data is transmitted with D4-compatible framing.

(d) SELF TST—This mode causes the T-BERD 209 to loop the transmit output to the receive input and perform a self-test using T1 data with ESF (Fe) framing. With this mode, the internal clock source is used regardless of the position of the TIMING switch. Upon leaving the SELF TST mode, the timing source reverts to that selected by the TIMING switch.

(e) T1C TLB—This mode causes the T-BERD 209 to retransmit the data it receives; incoming BPVs are stripped and BPVs, logic errors, and B8ZS line code can be imposed on the retransmitted data.

(f) T1 TLB—This mode also causes the T-BERD 209 to retransmit the data it receives. Incoming BPVs are stripped and BPVs, logic errors, and B8ZS line code can be imposed on the retransmitted data. The receiver analyzes the incoming data and automatically configures itself to accept the type of framed or unframed data being received.

(g) T1 LLB—In this mode, the receiver analyzes the incoming data and automatically configures itself to accept the type of framed or unframed data being received. In this mode, the T-BERD 209 also acts as a repeater—all data received by the T-BERD's receiver is echoed by the transmitter. BPVs are not stripped, and no BPV or logic errors can be inserted in this mode; line coding is not selectable in this mode.

(h) AUX—This mode allows operating parameters to be set for which dedicated switches are not provided. When the AUX position is selected, the PATTERN display will show the auxiliary function to be modified. Pressing the PATTERN switch will scroll the available auxiliary functions into the display. Once the desired auxiliary function is in the display, its parameters may be modified using the

RESULTS I and RESULTS II up (▲) and down (▼) arrow switches. The function of each of these switches varies for each auxiliary function. The upper line of the display above each RESULTS switch will indicate its use for a specific auxiliary function. The auxiliary functions are described in detail in Section 2.3.2.

(2) The **PATTERN** switch controls the actual data to be transmitted and informs the receiver as to which type of data is to be expected. Pressing the PATTERN switch allows the user to scroll through a list of available patterns; this list appears on the second line of the display immediately above the switch. Releasing the PATTERN switch selects the pattern currently displayed. Changing PATTERN selections causes a test restart. The nine available data patterns are listed below.

(a) ALL ONES, 1:1, 1:7, 3 IN 24—Fixed data patterns. The bit patterns are described in Section 7 (Specifications).

(b) 2^{15}-1, 2^{20}-1, 2^{23}-1—Pseudorandom data patterns.

(c) QRSS—Quasi-random signal source. This is a 2^{20}-1 pattern with 14-zero suppression.

(d) User-Defined Patterns—This position of the PATTERN switch allows the user to select a 3-to 24-bit pattern that is defined via remote control (see Section 5 for detailed information on remote control). The user may define up to a seven-character descriptive label to replace the factory-setting USER label in the display. The user-defined label and pattern are stored in non-volatile memory. The default label is USER and the default pattern is 1:3.

NOTE: Pressing either the LOOP UP or the LOOP DOWN switch will override the data pattern selection made by the PATTERN switch for the transmitter. When this occurs, the message LOOP UP or LOOP DN will be displayed in place of the pattern name while the loop pattern is being sent. When the loop code transmission is terminated, the previously selected pattern is restored, and its name will reappear in the display.

(3) **RESULTS I**—This is a set of two switches: a three-position switch with adjacent LED indicators and a two-position switch with up (▲) and down (▼) arrows. These switches select the results information to be viewed in the display immediately above the switches (Display I). The switch with adjacent LEDs allows the user to select one of three result categories: LOGIC, BPV & FRAME, and SIG & TIME. Pressing the switch allows the user to view each of the results available in that category; holding this switch down for more

than 1 second will automatically scroll through the entire list. This switch enables the user to scroll forward (▲) or backward (▼) through the list of results.

(4) **TIME SET/TIMED TEST/CONTINUOUS TEST**—This three-position switch has two maintained positions, CONTINUOUS TEST and TIMED TEST, and one momentary position, TIME SET. The CONTINUOUS TEST position allows for tests of unlimited duration. The TIME SET position allows the user to set a specific test time up to 200 hours and 59 minutes in 15-second increments.

NOTE: When in either the CONTINUOUS TEST or TIMED TEST position, results are cleared and the test restarted whenever any of the following front panel switches or side panel DIP switches are changed: PATTERN, MODE, RESTART, POWER, TIMING, RECEIVE INPUT, HALT/CONTINUE, or NO RESPONSE/AUTO RESPONSE. Changing from CONTINUOUS TEST to TIMED TEST also causes a test restart. However, changing from TIMED TEST to CONTINUOUS TEST does not cause a change in the accumulated results; results are simply added to those already accumulated.

The duration of a timed test is set using the TIME SET position. The test length entered is stored in the T-BERD 209's non-volatile memory. If a timed test is started without entering a new test duration, the test length last entered will be used. To set the test length for a timed test, the TIME SET/TIMED TEST/CONTINUOUS TEST switch should be pressed to the TIME SET position. Display II (above the RESULTS II switches) will show the previously entered test length in the format HH:MM:SS, with the hour digits flashing. The hour digits can be incremented (▲) or decremented (▼) by using the RESULTS II (TIME SET) switch. Once the hours have been set, pressing the momentary TIME SET position again will cause the minute digits to flash. Minutes are set in the same manner as hours, using the RESULTS II (TIME SET) switch. Seconds may be set in 15-second increments and are set in the same manner as hours and minutes. Pressing the TIME SET position a fourth time implements the test length and starts the timed test. It is not necessary to follow the entire time set sequence if, for instance, the user wishes to change only the hours. Pressing the RESTART switch or moving the TIME SET TIMED TEST switch to the CONTINUOUS position will save any part of the time interval that has been entered.

(5) **RESULTS II**—This set of switches selects the results information to be viewed in the display immediately above the switches (Display II) and operates exactly like the set of RESULTS I switches. The

switch with the up and down arrows (TIME SET) is also used in conjunction with the TIME SET/TIMED TEST/CONTINUOUS TEST switch to set the length of a time test.

(6) **DISPLAY HOLD**—When pressed, this momentary pushbutton switch freezes all of the results and alarm and status LEDs in their current state at the moment the switch is pressed. A red LED within the switch is illuminated to indicate that the displayed results are not current. If the switch is pressed again while the LED is illuminated, the hold mode is deactivated, the LED is turned off, and the current test results and LED displays are returned to the front panel.

(7) **RESTART**—When pressed, this momentary pushbutton switch clears all results and history LEDs and restarts the test.

(8) **HISTORY RESET**—When pressed, this momentary pushbutton switch clears all of the history indicators. Note that this switch does not restart a test and will not affect any of the current LED indicators or accumulated test results. This switch is not operable when the DISPLAY HOLD switch is activated.

(9) **LOOP DOWN**—This pushbutton switch controls the transmission of the loop-down codes, of which there are three types. The CSU loop-down code consists of one Mark followed by two Spaces (100) and the FACILITY loop-down code consist of three Marks followed by one Space (1110). The selection of either CSU or FACILITY loop codes is made via side panel DIP Switch 9. Alternatively, a 3- to 8-bit repeating user-programmable loop code sequence may be selected using the LP CODE and PGM LPDN auxiliary functions. Once the LOOP DOWN switch is pressed, this code is continuously transmitted until one of the following conditions occurs: (1) the loop-down code is no longer detected at the T-BERD's receiver; (2) the LOOP DOWN switch is pressed again; or (3) any of the MODE, PATTERN, RESTART, RECEIVE INPUT, or TIMING switches is pressed. The LED within the LOOP DOWN switch is illuminated for the period of transmission. This switch is disabled in T1 TLB, T1 LLB, and T1C TLB modes.

NOTE: When the LOOP DOWN switch is activated, the display normally showing the data pattern selected by the PATTERN switch will instead show the message LOOP DN to indicate loop-down code transmission. When loop-down code transmission is completed, the T-BERD will return to transmitting the data pattern previously selected, and the display will again reflect that selection.

(10) **LOOP UP**—This pushbutton switch controls the transmission of the loop-up codes, of which there are three types. The CSU loop-up

code consists of one Mark followed by four Spaces (10000) and the FACILITY loop-down code consist of two Marks followed by two Spaces (1100). The selection of either CSU or FACILITY loop codes is made via side panel DIP Switch 9. Alternatively, a 3- to 8-bit repeating user-programmable loop code sequence may be selected using the LP CODE and PGM LPUP auxiliary functions. This code is continuously transmitted until one of the following conditions occurs: (1) the T-BERD 209 detects the loop-up code on the receive side; (2) the LOOP UP switch is pressed again; or (3) any of the MODE, PATTERN, RESTART, RECEIVE INPUT, or TIMING switches is pressed. The LED within the LOOP UP switch is illuminated for the duration of the loop-up code transmission. This switch is disabled in T1 TLB, T1 LLB, and T1C TLB modes.

NOTE: When the LOOP UP switch is activated, the display normally showing the data pattern selected by the PATTERN switch will instead show the message LOOP UP to indicate loop-up code transmission. When loop-up code transmission is completed, the T-BERD will return to transmitting the data pattern previously selected, and the display will again reflect that selection.

(11) **POWER**—This pushbutton switch applies and removes power to the instrument.

(12) **TRANSMIT OUTPUT**—This three-position switch with adjacent LED indicators allows emulation of three different cable losses for T1 rates. The selected cable loss affects the transmit data only at the 15-pin D connector, the bantam connector, and the transmit 310 jack.

NOTE: When the MODE switch is set to transmit T1C data, the 0dB (DSX) position of the TRANSMIT OUTPUT switch is automatically selected (regardless of where the switch is manually positioned) and the corresponding LED is illuminated. When the MODE switch is set to transmit T1 data, the TRANSMIT OUTPUT switch reverts to the manually selected position.

(13) **RECEIVE INPUT**—This three-position switch with adjacent LED indicators selects the input impedance and signal conditioning. The BRIDGE position provides greater than 1000 ohms impedance for monitoring lines that are already terminated. The TERM position provides 100 ohms input impedance. Both the BRIDGE and the TERM positions provide Automatic Line Buildout (ALBO) which will compensate for up to 24 dB of cable loss for T1 or 6 dB of cable loss for T1C. The DSX-MON position provides both 100 ohms input impedance and amplification of the input signal. This

is useful for monitoring T1/T1C lines at DSX monitor points which are resistor-isolated. Changing this switch causes a test restart.

(14) **ERROR INSERT**—Two independent switches, BPV and LOGIC, are featured under the ERROR INSERT label. The BPV pushbutton switch will cause bipolar violation errors to be inserted into the data; the LOGIC pushbutton switch will cause logical bit errors to be inserted. Both of the switches contain red LEDs. Pressing either of the switches for less than 1 second causes a single error insertion, and the LED within the switch will be illuminated briefly. Holding either of the switches down for longer than 1 second will cause insertion of errors at a 1×10^{-3} error rate, and the LED within the switch will be illuminated continuously. When both the BPV and LOGIC switches are pressed for simultaneous error rate insertion (both LEDs will be illuminated), the BPV and logic errors are inserted in a manner which simulates errors as they would occur in repeatered spans. When the error occurs on a Space both the logic and the BPV error will occur on the same bit. When the error falls on a Mark the logic error will occur on that bit and the BPV error will occur on the following Mark. Errors and BPVs can be inserted on all transmitted data except when T1 LLB mode is selected. When both BPV and logic error insertion are active, errors are inserted without regard to B8ZS sequences, which may cause error multiplication as would be encountered on a repeatered span.

(15) **CODE**—This two-position switch with adjacent LED indicators selects whether the T-BERD 209 transmits with either normal AMI-encoded data or B8ZS clear channel encoding. This switch affects the transmitter only. On the receive side, B8ZS decoding is always available; the status LED labeled B8ZS will be illuminated when zero substitution codes are detected.

(16) **TIMING**—This three-position switch with adjacent LED indicators selects the transmit timing source. In the EXT (external) position, the transmit timing source is taken from the EXT BNC connector on the T-BERD 209's right side panel. If no clock source is present at the BNC connector when the EXT position is selected, the adjacent EXT indicator will flash to indicate the lack of a clock source. In the INT (internal) position, the transmit data is generated using the internal crystal oscillator at either T1 or T1C rates as selected by the MODE switch. In the RECOV (recovered) position, the transmit timing source is taken from the clock signal recovered from the received data. With recovered timing in T1 modes (except when operating in one of the loop modes—T1 TLB or T1 LLB), this clock signal has jitter removed from it before it is used as the transmit source. In all modes (except T1 TLB, T1 LLB, and T1C TLB), if the signal being received is not valid or if the frequency is too high or too low, the adjacent RECOV indicator will flash and

the internal clock source will automatically be used. Once the signal and the frequency become valid, the recovered clock source is used. Changing this switch causes a test restart.

2.3.2 Auxiliary Functions

As described in Section 2.3.1, the AUX position of the MODE switch allows operating parameters to be set for which there are no dedicated switches. These operating parameters are set through various auxiliary functions, which are accessed through and displayed above the PATTERN switch. This section describes each of the auxiliary functions and gives instructions for setting the related parameters.

PARITY

This auxiliary function allows any of the RS-232 Printer/Remote, or Printer/Remote/Slips options to transmit and receive RS-232 data with parity settings of either EVEN, ODD, or NONE. When the PARITY auxiliary function is selected, the following lines appear in the display.

AUX PARITY ODD
PARITY

The current selection of PARITY is shown in the upper line of the display as EVEN, ODD, or NONE (a selection of EVEN or ODD depends on the setting of the DIP switch). Changing the selection between PARITY EVEN/ODD and PARITY NONE is accomplished by pressing the RESULTS I switch up (▲) arrow. Selecting between PARITY EVEN and PARITY ODD must be made via the EVEN/ODD DIP Switch located above the AC receptable on the T-BERD's right side panel.

PGM PAT 1

This auxiliary function allows the user-programmable pattern 1 to be set. When selected, the current user pattern appears in the lower display line and the functions of the RESULTS I and RESULTS II switches appear in the upper display line (as shown below).

AUX	**FORWARD^ REV v**	**TOGGLE^ END v**
PGM PAT 1	**000111000111**	**000111000111**

A cursor will appear under the last bit of the pattern indicating the edit position. Use the following procedure to change the programmable pattern.

(1) Press the RESULTS I switch to position the cursor under the bit to be changed. The up (▲) arrow controls FORWARD movement; the down (▼) arrow controls REVerse movement.

(2) Press the RESULTS II switch up (▲) arrow to TOGGLE the bit from "1" to "0" or "0" to "1".

(3) To shorten the pattern length, position the cursor on the last desired bit position and press the RESULTS II switch down (▼) arrow to END the pattern. This step must be performed to save the pattern that was entered.

PGM PAT 2

This auxiliary function allows the user-programmable pattern 2 to be set. The pattern is set in the same manner as PGM PAT 1.

LOOP CODE

This auxiliary function allows selection of either the LOOP pattern determined via the CSU/FACILITY DIP switch or the user-defined loop codes set using auxiliary functions PGM LPUP and PGM LPDN. When the LOOP CODE auxiliary function is selected, the following lines appear in the display.

```
AUX          CSU LOOP CODE
LP CODE      10000    UP    100    DN
```

The current selection of loop code pattern is shown in the lower line of the display; the upper line indicates whether the CSU/FACILITY or PROGRAMMABLE pattern is selected (the display will show either CSU LOOP CODE or FAC LOOP CODE depending on the setting of the DIP switch). Changing the selection between CSU FAC LOOP CODE and PGM LOOP CODE is accomplished by pressing the RESULTS I up (▲) arrow switch. Selecting between CSU and FACILITY codes must be made via the CSU FACILITY DIP switch located above the AC receptable on the T-BERD's right side panel.

PGM LPUP

This auxiliary function allows the user-definable loop-up code to be set. When the PGM LPUP auxiliary function is selected, the following lines appear in the display.

```
AUX          FORWARD^ REVv      TOGGLE^ ENDv
PGM LPUP     XXXXXXX
```

The lower display line shows the current loop code setting. Programming new loop codes is performed in a maner similar to that used for setting the user-programmable pat ern. To change the loop-code sequence, perform the following procedure.

(1) Press the RESULTS I switch to position the cursor under the bit to be changed. The up (▲) arrow controls FORWARD movement; the down (▼) arrow controls REVerse movement.

(2) Press the RESULTS II switch up (▲) arrow to TOGGLE the bit value.

(3) Press the RESULTS I switch to position the cursor beneath the last character in the code and press the RESULTS II switch down (▼) arrow to END the code and set the code sequence length. This step must be performed to save the code that was entered.

PGM LPDN

This auxiliary function allows the user-definable loop-down code to be set. When the PGM LPDN auxiliary function is selected, the following lines appear in the display.

AUX FORWARD^ REVv TOGGLE^ ENDv
PGM LPDN XXXXXXX

The lower display line shows the current loop code setting. Programming new loop codes is performed in the same manner as for loop-up codes. To change the loop-down code sequence, perform the following procedure.

(1) Press the RESULTS I switch to position the cursor under the bit to be changed. The up (▲) arrow controls FORWARD movement; the down (▼) arrow controls REVerse movement.

(2) Press the RESULTS II switch up (▲) arrow to TOGGLE the bit value.

(3) Press the RESULTS I switch to position the cursor beneath the last character in the code and press the RESULTS II switch down (▼) arrow to END the code and set the code sequence length. This step must be performed to save the code that was entered.

2.3.1 Indicators

The T-BERD 209 front panel features various discrete alarm and status indicators. green LEDs are used to indicate positive conditions, red LEDs are used to indicate alarm or failure conditions. Three groups of indicators are described below, the numbers preceding the descriptions correspond to the numbers in Figure 2-1.

(17) **SIGNAL STATUS**—These green indicators are illuminated for at least 100 ms to provide information about the status and type of signal being received. The following is a list of the signal status indicators and their functions.

(a) T1 PULSES—This indicator is illuminated when a T1 signal is being received.

(b) T1C PULSES—This indicator is illuminated when a T1C signal is being received.

(c) PATTERN SYNC—This indicator is illuminated when pattern synchronization is achieved. Synchronization to a fixed pattern (ALL ONES, 1:1, 1:7, 3 IN 24, and the user-definable pattern) is declared when 30 consecutive error-free bits are received. For pseudorandom patterns, synchronization is declared upon the reception of 30 + n consecutive error-free bits for a pattern length of 2^n-1 (for the QRSS pattern, n = 20). If pattern synchronization is lost, this indicator is turned off.

(d) FRAME SYNC—This indicator is illuminated when synchronization is achieved to the selected framing pattern within the T1 data stream. The selected framing pattern is based on the mode (T1 D4, T1 ESF, T1 SLC, T1 TLB, T1 LLB). In T1 TLB and T1 LLB modes, the T-BERD 209 will automatically determine the framing type and configure itself to accept either unframed data, D4 framed data, or ESF framed data.

(e) B8ZS—This indicator is illuminated when B8ZS clear channel codes are detected in the received T1 or T1C signal.

(18) **ALARM Indicators**—These red indicators are illuminated when specific alarm conditions occur. When an alarm condition occurs, the indicator will remain illuminated for at least 100 ms. History indicators are also provided for each alarm condition; these indicators will be illuminated after the alarm condition has terminated, thereby providing a visual record that an alarm condition occurred at some point during the test. The following is a list of the alarm indicators and their functions.

(a) SIGNAL LOSS—This indicator is illuminated when no pulses are detected for 150 ms.

(b) PATTERN LOSS—After pattern synchronization is acquired, this indicator is illuminated whenever 250 bit errors are counted in less than 1000 bits of data, thereby signaling a loss of pattern synchronization. A pattern loss condition is terminated when pattern synchronization is reacquired.

(c) FRAME LOSS—This indicator is illuminated when 2 out of 5 Ft frame bits are detected in error for D4 or SLC-96 framing, or when 2 out of 5 frame bits are detected in error for ESF framing.

(d) EXCESS ZEROS—This indicator is illuminated when 16 or more consecutive zeros are detected in T1 modes, or when 34 or more consecutive zeros are detected in T1C modes.

(e) YELLOW ALARM—This indicator is illuminated when bit 2 of each channel has been forced to a zero for D4 or SLC-96 framing, or when the yellow alarm pattern (0000000011111111) is detected in the 4 kb/s data link for ESF framing. This alarm condition applies to framed T1 signals only.

(f) ALL ONES—This indicator is illuminated when 1024 consecutive ones are detected for T1C or unframed T1 signals, or when 128 consecutive DS0 channels contain all ones for T1 framed modes.

(g) POWER LOSS—This indicator is illuminated when the T-BERD is powered up, either after being manually turned off or after an accidental power loss. If a test was in progress at the time of the power loss, it will be automatically restarted when power is regained. The indicator itself will remain illuminated until the HISTORY RESET switch is pressed or until there is a major switch change that causes a test restart.

(19) **LOOP CODE**—These indicators provide information about loop codes being received by the T-BERD 209. The following is a list of the loop-code indicators and their functions.

(a) PRE-EXIST LOOP—This red indicator is illuminated when an in-band loop-up code is detected within 1.5 seconds from the start of loop-up code transmission. This indicator will remain illuminated for 5 seconds. When a pre-existing loop is detected, the transmission of the in-band loop-up code is immediately halted.

(b) LOOP UP—This green indicator is illuminated whenever an in-band loop-up code is being received by the T-BERD 209. The presence of a loop-up code can be detected with a 10^{-3} error rate and with or without T1 framing.

(c) LOOP DOWN—This green indicator is illuminated whenever an in-band loop-down code is being received by the T-BERD. The presence of a loop-down code can be detected with a 10^{-3} error rate and with or without T1 framing.

(d) TLB—This green indicator is illuminated whenever the out-of-band Test Loopback signal is detected; that is, when Pin 8 of the 15-pin D connector is positive with respect to Pin 7 and 15 mA or more current is detected between Pins 7 and 8.

(e) LLB—This green indicator is illuminated whenever the out-of-band Line Loopback signal is detected; that is, when Pin 7 of the 15-pin D connector is positive with respect to Pin 8 and 15 mA or more current is detected between Pins 7 and 8.

2.3.4 Connectors

The T-BERD 209 features several connectors on its front panel; these connectors are described below. The numbers preceding the descriptions correspond to the numbers in Figure 2-1.

(20) **DSX OUTPUTS**—Three WECO 310 jacks provide DSX-level transmit outputs. Each output provides a 3-volt base-to-peak output into a 100-ohm load. Any one or all three of these outputs may be used simultaneously.

(21) **TRANSMIT OUTPUTS**—One WECO 310 jack, one BANTAM jack, and the 15-pin D connector provide the transmit output after it has passed through a switchable line buildout circuit. The line buildout (T1 only) circuit inserts artificial line sections with either 7.5 or 15 dB of loss at 772 kHz or bypasses the artificial lines, presenting a DSX-level output. These connectors also provide the simplex current path to the receiver input jack. Note that only one of these output connectors should be used at any one time as the output source.

(22) **CONNECTOR**—A female, 15-pin D connector is provided for connection to the CSU or to the local loop. A 15-pin male-to-male cable is used to connect to the customer side of the CSU or to the local loop network interface connector. This connector is used in lieu of the TRANSMIT OUTPUTS and the RECEIVE INPUTS.

(23) **RECEIVE INPUTS**—One WECO 310 jack, one BANTAM jack, and the 15-pin D connector accept the receive input signal. The RECEIVE INPUT switch determines whether the input is terminated into 100 ohms or bridged, and whether ALBO or AGC circuits are used to accommodate signals attenuated by either cable or resistive circuits. Note that only one of these connectors should be used as the receive input at any one time.

2.4 MEASUREMENTS

The T-BERD 209 T-Carrier Analyzer performs a variety of measurements. These measurements are divided into three different categories: LOGIC, BPV &

FRAME, and SIGNAL & TIME. These three categories and the results available in each are discussed in the following paragraphs. Table 2-1 lists, by result category, the displayed result names, the result number, and a brief description of each result.

The LOGIC category contains results that are based on a count of bit errors. The bit error count is updated each time bit errors are detected in the data pattern that is selected by the PATTERN switch. During a test when pattern synchronization is lost, the bit error count either continues to count or halts, depending on the position of the HALT/CONTINUE DIP switch. The slip count is a count of the total number of pattern slips since the beginning of the test. A pattern slip is detected if one or more bits are missing from or added to the expected pseudorandom bit sequence. In addition to these results, a set of performance analysis results, such as severely errored seconds, available seconds, and degraded minutes, are included in the Performance Analysis Option (see Section 8 for further information on this option).

The results in the BPV & FRAME category are designed for monitoring T-carrier spans which are in service. In this category, the elementary results are bipolar violation counts and frame error counts. The T-BERD 209 increments a bipolar violation count each time that successive T1 or T1C pulses of the same polarity are detected, except when part of a B8ZS substitution code. These bipolar violations are displayed under the result VIOLATIONS and are the basis for calculating BPV seconds and BPV rate. For the frame error count, the T-BERD 209 analyzes the frame information embedded within a T1 signal. Frame bit errors in D1D, D2, D3, or D4 framing signals are detected and used as the basis for calculating framing error rate and frame losses. The number of frame synchronization losses and the number of seconds in which frame synchronization was lost are also displayed. For T1 circuits with ESF framing, the T-BERD 209 will detect and accumulate CRC-6 errors; the CRC errors are then used to calculate the CRC error rate and to accumulate CRC errored seconds.

The third category of results is the SIGNAL & TIME category. For signal measurements in the SIGNAL & TIME category, the T-BERD measures the magnitude of the simplex current flowing between the Tx output tip and ring and the Rx input tip and ring. The current can be measured over the range of 10 mA to 180 mA. It also performs two types of level measurement. The first is the measurement of peak voltage level and is expressed in dB relative to a standard 3-volt, base-to-peak signal (dsx level). This measurement is displayed in dBdsx and is valid for any T1 or T1C signal. The second measurement is displayed in dBm and may be performed only on an all-ones signal. TIME measurements include test seconds, alarm seconds, and signal loss seconds. With either the Printer Interface Option, the Printer Remote Control Interface option, or the Printer Remote Slips Interface option, a real-time clock and date are available. With the Printer Remote Slips Interface option, timing slips and slip analysis seconds measurements are provided. LED indicators display the results of circuitry which detects sync loss, yellow alarm, and all ones. The current signal status is continuously displayed, and history indicators are illuminated and remain on after an alarm condition has terminated. Signal loss seconds, frame loss seconds, and alarm seconds are accumulated.

Table 2-1—Displayed Results

LOGIC CATEGORY		
RESULT NUMBER	**DISPLAYED RESULT NAME**	**DESCRIPTION**
0	BIT ERRORS	A count of received bits which have a value (Mark or Space) opposite that of the corresponding transmitted bits after pattern synchronization was achieved.
1	ASYNC ERR SEC	A count of test seconds during which one or more bit errors occurred.
	BIT ERR RT	The ratio of bit errors to received pattern data bits.
5	ER FREE SEC	A count of seconds during which pattern synchronization was maintained through the entire second and no bit error occurred.
6	% EFS	The ratio, expressed as a percentage, of error-free seconds to the total number of seconds during which pattern syncronization was present.
7	SYN ERR SEC	A count of errored seconds synchronized to the occurrence of an error (the count and time interval begin with the occurrence of an error).
8	OUT SYN SEC	A count of the total number of seconds since the beginning of the test during which pattern synchronization was not maintained for the entire second.
9	SLIPS	A count of the total number of pattern slips since the beginning of the test.
10	SEV ERR SEC*	A count of seconds during which the bit error ratio was worse than 1×10^{-3} within available time.
11	%SEV ER SEC*	The ratio, expressed as a percentage, of severely errored seconds to the number of available seconds.
12	DEGR MIN*	A count of minutes during which the bit error ratio was worse than 1×10^{-6}.
13	%DEGR MIN*	The ratio, expressed as a percentage, of degraded minutes to the number of available minutes.
14	UNAVL SEC*	A count of unavailable time.
15	%AVLBILITY*	The ratio, expressed as a percentage, of available seconds to the number of test seconds.
16	CSES	A count of the number of groups of three or more contiguous seconds in which an error rate worse than 1×10^{-3} was found in each second.

* These results available only with the Performance Analysis Option (See Appendix A.)

Table 2-1—Displayed Results (Cont.)

BPV & FRAME CATEGORY		
RESULT NUMBER	**DISPLAYED RESULT NAME**	**DESCRIPTION**
25	VIOLATIONS	A count of bipolar violations detected since test start, excluding intentional violations found within B8ZS codes.
26	BPV SECONDS	A count of seconds within which one or more bipolar violations occurred.
27	BPV RATE	The ratio of bipolar violations to the number of data bits received.
28	FRM ERR SEC	A count of seconds during which one or more frame errors occurred.
29	FRAME SES	A count of seconds during which the TOTAL number of frame errors equalled 12 or more.
30	FRM ERRORS	Frame errors are counted if either an Ft or an Fs frame bit is in error for D4 compatible framing. In T1 SLC mode, frame errors are counted only if an error is found on an Ft bit.
31	FRM ER RATE	The ratio of frame errors to the number of analyzed framing bits.
32	CRC ERRORS	A count of CRC errors detected. Counted only when ESF framing is present in the received T1 data.
33	CRC ERR SEC	A count of seconds within which one or more CRC errors was detected.
34	FRM LOS CNT	A count of discrete losses of frame synchronization that occurred during the test.
35	FRM LOS SEC	A count of seconds since initial frame synchronization during which one or more frame synchronization losses occurred or during which frame synchronization could not be achieved.
36	CRC SES	A count of seconds during which the total number of CRC errors and frame synchronization losses equalled 320 or more.
37	CRC ERR RT	A count of CRC-6 errors divided by the total number of ESF superframes analyzed.

Table 2-1—Displayed Results (Cont.)

SIG & TIME CATEGORY		
RESULT NUMBER	**DISPLAYED RESULT NAME**	**DESCRIPTION**
40	RX FREQ, Hz	The frequency of the clock recovered from the received data.
41	RX LEVEL dBdsx	The level of the received signal in dB relative to a standard 3-volt base-to-peak signal (DSX level).
42	RX LEVEL dBm	The power level of an all-ones signal (applicable only when all ones is detected).
43	SPX CURRENT	The magnitude of the simplex current flowing between the Tx output tip and ring and the Rx input tip and ring.
44	SIG LOS SEC	A count of test seconds during which the signal was not present or during which one or more signal losses occurred.
45	ALARMED SEC	A count of test seconds during which a Yellow, All Ones, or Excess Zeros alarm was detected.
46	TEST LENGTH	The currently set test length for a timed test, in HHH:MM format.
47	TEST SECOND	A count of seconds (1) since a signal of proper frequency and level has been detected, or (2) since the last major switch change.
48	TEST END IN	Time remaining in a timed test, in HHH:MM:SS format.
49	CLOCK TIME	The time of day in HH:MM:SS format.
50	DATE	The date in DD MON format.
51	SLP ANA SEC	A count of test seconds during which Timing Slip Analysis has been performed.
52	TIMING SLIP	Timing slips are counted when the RECEIVER input has slipped 193 bit time periods from the T1-REF input. Single bit slips are displayed graphically next to timing slips.
54	ELAPSED TIME	The number of hours, minutes, and seconds (1) since a proper frequency and level has been detected or (2) since the last major switch change.
55	RX LEVEL Vp-p	The peak signal level of the received signal in volts.

2.5 SIDE PANEL DIP SWITCHES AND CONNECTORS

The T-BERD 209's right side panel features DIP switches and several connectors. These switches and connectors are described in the following paragraphs.

2.5.1 DIP Switches

Ten DIP switches, numbered from 1 to 10, are located on the T-BERD side panel. Each switch has an up and a down position; the down position is labeled OPEN. The up position is the "normal" position. The following list describes each of the switches; the switches are numbered as they appear on the T-BERD side panel.

(1) **HALT/CONTINUE**—This switch controls the T-BERD's reaction to a loss of pattern synchronization. The HALT (up) position freezes all LOGIC results when a sync loss is declared and resumes the test when sync is reacquired. The CONTINUE (down) position causes error and slip counting to continue throughout the synchronization loss. HALT is the normal position. This switch causes a test restart.

(2) **OVERWRITE/IMBED**—This switch controls the T-BERD's method of framing the transmitted loop codes. The OVERWRITE (up) position causes a loop-code bit to be replaced by a frame bit every 193 bits. The IMBED (down) position causes the frame and loop-code bits to be interleaved. OVERWRITE is the normal position.

(3) and (4) **BAUD RATE**—Two switches control the baud rate of the optional printer and printer/remote control interfaces. Table 2-2 shows the baud rate selections and the corresponding switch positions.

Table 2-2
Baud Rate Selections

Baud Rate	Switch 3	Switch 4
300	Down	Down
1200	Down	Up
2400	Up	Up
4800	Up	Down

(5) **EVEN/ODD**—This switch controls the parity bit of the optional printer and printer/remote control interfaces. The EVEN (up) position selects even parity; the ODD (down) position selects odd parity. EVEN is the normal position.

(6) **CR/CRLF**—This switch controls the terminating sequence transmitted at the end of each line of data by the printer/remote interface. The CR (up) position terminates each line with a carriage return (0DH) character. The CRLF (down) position terminates each line with the carriage return (0DH) and line feed (0AH) characters. CR is the normal position.

(7) **NORMAL/SHORT**—This switch controls the type of print format used with the optional printer/remote interface. The NORMAL (up) position selects a print format with all results printed (normal format). The SHORT position selects an abbreviated print format. Print formats are described in detail in Section 5.

(8) **20/80**—This switch selects between a 20-column print format (up) and an 80-column print format (down). The 20-column print format is the normal position.

(9) **CSU/FACILITY**—This switch selects the type of loop code: (1) to which the LOOP UP and LOOP DOWN indicators will respond; and (2) which initiates the AUTO RESPONSE function. When the LOOP CODE auxiliary function is set to CSU/FAC LOOP CODE, the DIP switch also determines the type of loop code to be transmitted when using the LOOP UP or LOOP DOWN switches.

(10) **NO RESPONSE/AUTO RESPONSE**—This switch conditions the T-BERD 209 to automatically respond to loop codes. In the NO RESPONSE position, the T-BERD will not change mode and will simply display the loop codes' presence. The AUTO RESPONSE position causes the T-BERD to act as a CSU in response to the reception of loop codes. If 5 seconds of in-band loop-up codes are received, the T-BERD will automatically save its current MODE and enter Line Loopback (AUTO LLB) mode. The T-BERD then repeats via the transmitter all data received. Subsequently, the reception of a proper loop-down code sequence will cause the T-BERD to exit the AUTO LLB mode and return to its previous mode. AUTO LLB mode functions identically to T1 LLB mode. The out-of-band loop code will be declared immediately upon its detection. The receive line loopback (LLB) code and receive test loopback (TLB) codes are detected with Pins 7 and 8 of the 15-pin D connector. When either of these out-of-band codes is detected, the T-BERD will automatically save its current mode and enter the appropriate AUTO TLB or AUTO LLB mode for as long as the code is detected.

If AUTO RESPONSE is active and the T-BERD mode is set to T1C, T1C TLB, or T1 LLB, when a loop code is detected the T-BERD will respond only by illuminating the LOOP UP or LOOP DOWN receive LEDs. It will not enter AUTO LLB mode.

The detection of in-band loop codes is directly dependent upon the position of the CSU/FACILITY DIP switch since that switch determines which patterns the T-BERD will recognize as loop codes.

Changing this switch causes a test restart.

2.5.2 Connectors

A power receptacle and two connectors are featured on the T-BERD 209's right side panel. The following paragraphs describe these connectors.

A 3-pin receptacle is provided for 115 VAC 60 Hz operation; the safety ground connection is wired directly to the chassis. The line fuse compartment is located directly above the 3-pin receptacle and contains a spare fuse.

WARNING: Ground the instrument. To minimize shock hazard, the instrument chassis must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

CAUTION: The T-BERD 209 should be operated with a 500mA, 250V, slow-blow fuse installed (Littlefuse #218.500 or equivalent.) Always use correct fuse size.

The BNC connector located on the side panel can be used to input an external clock source. This clock source is selected and used to generate data when the front panel TIMING switch is set to the EXT position. This input is AC coupled and has a 50-ohm input impedance.

A female 25-pin D connector is provided and configured with DCE pin out to connect the T-BERD to a printer, terminal, or computer when either the RS-232 Printer Interface option or the RS-232 Printer Remote Control Interface option is installed.

2.6 PULL-OUT REFERENCE CARD

The T-BERD 209 features a pull-out card which furnishes quick reference information including: (1) a list of the available MODE and PATTERN selections;

(2) instructions on setting the time for a timed test as well as for the real-time clock and calendar; (3) the settings for the side panel DIP switches; and (4) a list of the available results, grouped by category and sorted by result number.

The card is stored below the front panel; to pull out the card, locate the semi-circular notch in the front center of the T-BERD's bottom panel and slide the card straight out. The card remains attached to the instrument but is hinged so that it may be folded down for better visibility when the instrument is resting on its back panel.

SECTION 3
PREPARATION FOR USE

3.1 INTRODUCTION

This section provides information on preparing the T-BERD 209 for use. Specifically included are instructions for unpacking and inspecting the instrument; a list of the equipment that should be contained in the shipment; and an instrument checkout procedure.

3.2 UNPACKING

The T-BERD 209's shipping container should be inspected for damage when it is received. If the shipping container or shipping material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking the electrical performance of the instrument are given in Section 3.4. If the contents are incomplete, or if the T-BERD 209 does not pass the performance tests, the customer should notify TTC. If the shipping container is damaged, notify the carrier as well as TTC, and keep the shipping container and materials for the carrier's inspection.

3.3 EQUIPMENT INCLUDED

The following is a list of the equipment that should be present when the T-BERD 209 shipment is received and unpacked.

(1) T-BERD 209 T-Carrier Analyzer
(2) AC Line Cord
(3) Operating Manual

3.4 INSTRUMENT CHECKOUT

As recommended in Section 3.2, the T-BERD 209 should be checked mechanically and electrically upon unpacking. To verify proper electrical operation, perform the following steps. To ensure that the proper results are selected during this procedure, the result names are followed by the result number in parentheses.

(1) Remove the cover of the T-BERD 209 by unsnapping the metal latches on each side of the instrument. Turn the cover upside down and access the AC line cord compartment by simultaneously compressing the squeeze latches on the compartment panel and lifting the panel out of the cover.

(2) Insert the AC line cord into the AC receptacle on the T-BERD 209's side panel and plug the other end of the cord into a 115 VAC power source.

WARNING: Ground the instrument. To minimize shock hazard, the instrument chassis must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

CAUTION: The T-BERD 209 should be operated with a 500mA, 250V, slow-blow fuse installed (Littlefuse # 218.500 or equivalent.) Always use correct fuse size. (See Section 6 for fuse replacement instructions.)

(3) Apply power to the T-BERD 209 by pressing the POWER switch on the bottom right corner of the instrument's front panel. All front panel indicators will be illuminated for approximately 1 second; the displays, the POWER LOSS indicator, and those LED indicators noting current switch positions will remain illuminated after the 1-second lamp test. The POWER LOSS indicator may be turned off by pressing the HISTORY RESET switch.

(4) Set the operating mode to self-test by pressing the MODE switch and scrolling through the available modes until SELF TST appears in the display. The self-test mode is now implemented; this internally connects the T-BERD 209's transmitter to its receiver and automatically selects ESF framing and internal T1 crystal timing. A different pattern can be selected by pressing the PATTERN switch and scrolling through the available patterns until the desired pattern appears in the display. Regardless of the pattern that is selected, the following LED indicators should light: T1 PULSES, PATTERN SYNC, and FRAME SYNC. The following LED indicators may light depending on the pattern selected: B8ZS, ALL ONES, EXCESS ZEROS, and EXCESS ZEROS HISTORY

(5) Set the RECEIVE INPUT switch to the TERM position and the TRANSMIT OUTPUT switch to the 0 dB position. Set the RESULTS 1 switch to the SIG & TIME position and, using the corresponding ▲▼ switch, scroll through the available results until the RX LEVEL (41) result appears in Display 1. The value shown for this result should be 0 dBdsx ± 1 dB. Set the TRANSMIT OUTPUT switch to -7.5 dB and confirm that the RX LEVEL result changes to -7 dBdsx ±2dB. Set the TRANSMIT OUTPUT switch to -15 dB and confirm that the RX LEVEL result changes to -15 dBdsx ±3 dB.

(6) With the RESULTS I switch still in the SIG & TIME position, scroll the RX FREQ (40) result into Display I. The value shown for this result should be between 1543984 Hz and 1544016 Hz.

(7) Press the RESTART switch. Set the RESULTS II switch to the BPV & FRAME position and scroll the VIOLATIONS (25) result into Display II. The value shown for this result should be 0. Press and release the BPV ERROR INSERT switch several times and verify that the violation count in the display increments by 1 each time the switch is pressed.

(8) Set the RESULTS I switch to the LOGIC position and scroll the BIT ERRORS (00) result into Display I. The value shown for this result should be 0. Press and release the LOGIC ERROR INSERT switch several times and verify that the bit error count in the display increments by 1 each time the switch is pressed.

(9) Using a bantam or WECO 310 patch cord, loop the TRANSMIT output to the RECEIVE input. Press the MODE switch to select T1C mode. Set the TIMING switch to the INT position. Set the RESULTS I switch to the SIG & TIME position and scroll the RX FREQ (40) result into Display I. Confirm that the received frequency is between 3151968 Hz and 3152032 Hz.

(10) Press and hold the LOGIC ERROR INSERT switch until the LED within the switch is continuously illuminated. Press and hold the BPV ERROR INSERT switch until the LED within the switch is continuously illuminated. Press the RESTART switch. Set the RESULTS I switch to the LOGIC position and scroll the BIT ERR RT (04) result into Display I. Set the RESULTS II switch to the BPV & FRAME position and scroll the BPV RATE (27) result into Display II. After 10 seconds, both of the displays should show between 9.0 E-07 and 1.1 E-06.

(11) If the Performance Analysis Option is installed in the T-BERD 209 being tested, confirm by scrolling through the LOGIC category that the following results are available: SEV ERR SEC (10); %SEV ERR SEC (11); DEGR MIN (12); %DEGR MIN (13); UNAVL SEC (14); %AVLBILITY (15).

During the self-test, the T-BERD 209's non-volatile RAM (NOVRAM) is checked because, at power-up, the T-BERD restores the instrument to the settings that were selected before the last power-down. If any changes are found, the factory settings are reloaded and the message RELOAD NOVRAM will be displayed. The T-BERD remains fully functional even though switch settings may not have been saved during the power cycle. While the instrument may be used, TTC should be called for service.

The instrument's RAM, EPROM, and microprocessor are also checked during the self-test. If any error is found, the messages BAD RAM, BAD ROM, or BAD PROCESSOR will be displayed. In this event, TTC should be called for service. There are no user-serviceable parts within the T-BERD 209.

SECTION 4
OPERATION

4.1 INTRODUCTION

This section contains instructions for using the T-BERD 209 T-Carrier Analyzer to test the performance of T-carrier communications links. Specifically included are step-by-step procedures for (1) both in-service and out-of-service testing of T1, SLC-96, and T1C lines; (2) simplex current measurement and CSU emulation; (3) signal level measurement; and (4) timing slips measurement. The following procedures assume that the user is familiar with the location and operation of the T-BERD 209's front panel controls; unfamiliar users should refer to Section 2 (Functional Description).

4.2 T1 TESTING

4.2.1 Out-of-Service Testing

To test the error performance of a T1 span line, perform the following steps.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Depending on the type of data format expected on the T-carrier circuit under test, press the MODE switch to set the T-BERD for T1, T1 D4, or T1 ESF framing.

(3) Press the PATTERN switch to select the QRSS data pattern.

(4) Set the TIME SET TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(5) Set the TIMING switch to the RECOV(LOOP) position if timing is to be recovered from the received data. Set the TIMING switch to the INT position if loop timing is not a requirement.

(6) Set the CODE switch to either the B8ZS or AMI position, as appropriate.

(7) Ensure that both of the ERROR INSERT switches (BPV and LOGIC) are in the OFF position (the switches are off when the LEDs within the switches are NOT illuminated). If an LED is illuminated, press the switch once to turn the LED and error insertion off.

(8) Set the RECEIVE INPUT switch to the TERM position.

(9) Set the TRANSMIT OUTPUT switch to the 0 dB (DSX) position.

(10) Connect the TRANSMIT and RECEIVE connectors to the circuit to be tested.

(11) Establish a loop at the far end of the circuit.

NOTE: Depending on the circuit's configuration, there are several methods by which a loop may be established; these methods are described below.

(a) If a CSU which has a loop-code response feature is located at the far end of the circuit, simply set side panel DIP Switch 9 to the up (CSU) position and press the LOOP UP switch on the front panel. When the loop is established, the T-BERD will stop sending the loop-up code and begin the test. If the far-end CSU does not respond to the loop code, press the LOOP UP switch a second time to terminate the loop-code transmission.

(b) If a Facility Loopback Unit (FLU) is located at the far end of the circuit, set DIP Switch 9 to the down (FACILITY) position and press the LOOP UP switch on the front panel. When the loop is established, the T-BERD will stop sending the loop-up code and begin the test. If the far-end FLU does not respond to the loop code, press the LOOP UP switch a second time to terminate the loop-code transmission.

(c) The final alternative is to manually establish a loop at the far end.

(12) Press the RESTART switch to begin the test once the loop is established.

(13) The following conditions should be observed:

(a) The T1 PULSES indicator is illuminated.
(b) The PATTERN SYNC indicator is illuminated.
(c) The FRAME SYNC indicator is illuminated if either the T1 D4 or T1 ESF mode was selected.
(d) The B8ZS indicator is illuminated if clear channel (B8ZS) line coding is detected.

(14) Set the RESULTS I switch to the SIG & TIME position and scroll the RX FREQ result into Display I.

(15) Verify that the frequency displayed is between 1543923 Hz and 1544077 Hz.

(16) IScroll the RX LEVEL (41) result into Display I and verify that the level shown is between -2 dBdsx and +2 dBdsx.

(17) Verify that none of the red alarm indicators are illuminated.

(18) Set the RESULTS I switch to the LOGIC position and scroll the BIT ERRORS result into Display I.

(19) Set the RESULTS II switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display II.

(20) If no bit errors or violations are detected, then both displays will show a result of 0. If bit errors and violations are detected, Display I will show a bit error count and Display II will show a violation count. If only bit errors are being counted, and the violation count remains at 0, it is likely that errors are being introduced before the last repeatered span.

(21) With the RESULTS I switch still in the LOGIC position, scroll the SLIPS result into Display I.

(22) Verify that the SLIPS result is 0. If the circuit is using a framed data format and slips are being counted, but there are no frame sync losses occurring, then controlled frame slips are probably occurring. Controlled frame slips can occur when multiplexers or DACS are used in a circuit with equipment that is not slaved (loop timed) to a common clock.

(23) If errors were detected in Step (20) or slips were detected in Step (22), the user may perform an end-to-end test using a second T-BERD 209 similarly configured at the far end of the span. This will allow the two T-BERDs to exchange data and allow further sectionalization.

4.2.2 In-Service Monitoring

To monitor a T1 circuit at a DSX patch bay or the monitor jacks of a CSU without disrupting the T1 service, perform the following steps.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Press the MODE switch to select T1 TLB mode (this mode is selected because it automatically conditions the receiver for the type

of framed or unframed data present in the received signal; if the data format is known, the T1, T1 D4, or T1 ESF modes can be used).

NOTE: If the T1 link being monitored has SLC-96 data format, the T1 SLC mode must be selected. This will prevent false accumulation of frame errors by conditioning the receiver to ignore framing bits that are used as a data link in the SLC-96 data format.

(3) Set the TIME SET/TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(4) Set the RECEIVE INPUT switch to the DSX-MON position. (Set switch to the BRIDGE position if monitor jacks are not resistor isolated.)

(5) Connect the T-BERD 209 to the MON jack on the DSX patch bay or CSU. If a T1 signal is present, the T1 PULSES indicator will be illuminated. If the signal contains either D4 or ESF (Fe) framing, the FRAME SYNC indicator will be illuminated. If the link monitored is operating with clear channel (B8ZS) line coding, the B8ZS indicator will be illuminated.

(6) Press the RESTART switch to begin the test.

(7) Set the RESULTS I switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display I. If no bipolar violations are detected, the display will show 0. If bipolar violations are detected, the display will show a violation count.

(8) If the FRAME SYNC indicator is illuminated, scroll the FRM ERRORS result into Display I. If the result is a numeric value, the monitored data contains a D4 framing pattern. If the display shows N/A, the monitored data contains an ESF framing pattern; in this case, scroll the CRC ERRORS result into the display. If either frame errors or CRC errors are found at this point, but not in step (7), it is likely that errors are being introduced before the last repeatered span.

(9) Set the RESULTS II switch to the SIG & TIME position and scroll the RX LEVEL (41) result into Display II. Observe that the signal level is between -18 dBdsx and -22 dBdsx (a 20 dB loss is incurred due to the isolation resistors in the monitor jacks; if the jacks are not isolated, the level will be between -2 dBdsx and +2 dBdsx).

(10) Scroll the RX FREQ result into Display II and observe that the measured frequency is betweeen 1543923 Hz and 1544077 Hz.

4.3 SIMPLEX CURRENT MEASUREMENT AND CSU EMULATION

To measure the simplex current at a CSU or to replace the CSU with the T-BERD 209 for out-of-service testing, perform the following steps.

> **NOTE:** One of the functions of the CSU is to complete the current path for powering the regenerative repeaters on the span. **HAZARDOUS VOLTAGES EXIST ON THE LINE SIDE OF THE CSU** and local telephone company office alarms may sound when the current path is interrupted. Since telephone companies do not have a uniform policy regarding the disconnection of the CSU from the span, **LOCAL TELEPHONE COMPANY INTERVENTION IS STRONGLY RECOMMENDED.** Advance notice should be given so that power can be removed from the span prior to disconnection of the CSU.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Depending on the type of data format for which the T-carrier span is conditioned, press the MODE switch to set the T-BERD for T1, T1 D4, or T1 ESF framing.

(3) Press the PATTERN switch to select the QRSS data pattern.

(4) Set the TIME SET TIMED TEST CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(5) Set the TIMING switch to the RECOV(LOOP) position if timing is to be recovered from the received data. Set the TIMING switch to the INT position if loop timing is not a requirement.

(6) Set the CODE switch to either the B8ZS or AMI position, as appropriate.

(7) Ensure that both of the ERROR INSERT switches (BPV and LOGIC) are in the OFF position (the switches are off when the LEDs within the switches are NOT illuminated). If an LED is illuminated, press the switch once to turn the LED and error insertion off.

(8) Set the RECEIVE INPUT switch to the TERM position.

(9) The correct setting of the TRANSMIT OUTPUT switch must be determined. This can be accomplished by either examining the CSU for its setting or contacting the local operating company. Set the TRANSMIT OUTPUT switch to 0 dB, -7.5 dB, or -15 dB, as appropriate.

(10) **DANGER: HIGH VOLTAGE MAY BE ENCOUNTERED.** Upon determination that power has been removed from the span line, disconnect the CSU from the span line.

(11) Connect the span line to the T-BERD using (1) the 15-pin D connector (if a 15-pin D connector is supplied); (2) the Model 10558 cables (if bare wires or spade lugs are supplied); or (3) the Model 10686 cable (if RJ45 connectors are supplied).

(12) Have the span line power restored. Set the RESULTS I switch to the SIG & TIME position and scroll the SPX CURRENT result into Display I. Observe that the SPX CURRENT result is between 54 mA and 66 mA for low-power repeatered spans, or between 126 mA and 154 mA for high-power repeatered spans.

(13) Set the RESULTS II switch to the SIG & TIME position and scroll the RX LEVEL (41) result into Display II. Observe that the receiver level is between 0 dBdsx and -22 dBdsx per Bell System Technical Reference 62411, Section 5.6.1. The proper setting of the transmit LBO can be determined by adding the loss measured here to the setting of the TRANSMIT OUTPUT switch. Note that the result must be between -15 dBdsx and -22.5 dBdsx. For example, if the level measured is -12 dBdsx, the TRANSMIT OUTPUT switch must be set to -7.5 dBdsx ([-12 dBdsx] + [-7.5 dBdsx] = -19.5 dBdsx).

(14) An error performance test may also be performed by following Steps (11) through (22) in Section 4.2.1 (T1 Out-of-Service Testing).

4.4 SIGNAL LEVEL MEASUREMENT

To measure input and output signal levels at an in-service CSU, perform the following steps.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Press the MODE switch to select T1 mode.

(3) Set the RECEIVE INPUT switch to the BRIDGE position.

(4) Set the TIME SET TIMED TEST CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(5) **DANGER: HIGH VOLTAGE MAY BE ENCOUNTERED.** Connect the T-BERD 209 RECEIVE INPUT to the receive line (from central office) terminals.

(6) Observe that the T1 PULSES indicator is illuminated.

(7) Set the RESULTS I switch to the SIG & TIME position and scroll the RX LEVEL (41) result into the display. Observe that the level measured here is between 0 dBdsx and -22 dBdsx per Bell System Technical Reference PUB62411, Section 5.6.1.

(8) **DANGER: HIGH VOLTAGE MAY BE ENCOUNTERED.** Connect the T-BERD 209 RECEIVE INPUT to the transmit line (toward central office) terminals.

(9) The level of the signal reaching the repeater must be between -15 dBdsx and -22 dBdsx; to obtain this level, the correct line buildout pad must be installed in the CSU. To confirm the level, measure the output level of the CSU and add it to the measurement in step (7). The result should be between -15 dBdsx and -22 dBdsx. For example, if a measurement of -12 dBdsx is obtained in step (7) and a measurement of -8 dBdsx is obtained in step (9), then the level of the signal reaching the repeater is -20 dBdsx ([-12 dBdsx] ± [-8 dBdsx] = -20 dBdsx).

4.5 SLC-96 TESTING

The T-BERD 209 can be used for either in-service monitoring or out-of-service testing of a T1 span used in an SLC-96 system.

4.5.1 Out-of-Service Testing

Out-of-service testing can be performed on an SLC-96 system without interrupting customer voice or data. This is accomplished by switching the data carried by the T1 line to be tested to the protection spare. The following steps describe this procedure.

(1) Determine if the protection spare T1 span is in use by examining the LEDs of each Line Interface Unit (LIU) for shelves A, B, C, and D. The LED labeled LINE ON PROT on the LIUs will be illuminated when an error threshold in the corresponding T1 span has been exceeded and the T1 span has been put out of service. This span should then be tested and repaired prior to testing another span, otherwise, service may be interrupted. If none of the LIUs are on protection, then any of them may be tested.

(2) Install a pin plug into the pin jack labeled F END LP of the LIU to be tested.

(3) Connect an LIU Test Cord (a 15-pin D to edge connector cable) from the LIU to the JACK PANEL. Press the POWER switch to apply power to the T-BERD 209.

(4) Press the PATTERN switch to select the QRSS data pattern.

(5) Set the TIME SET/TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(6) Set the TIMING switch to the INT position.

(7) Set the CODE switch to either the B8ZS or AMI position, as appropriate.

(8) Ensure that both of the ERROR INSERT switches (BPV and LOGIC) are in the OFF position (the switches are off when the LEDs within the switches are NOT illuminated). If an LED is illuminated, press the switch once to turn the LED and error insertion off.

(9) Set the RECEIVE INPUT switch to the TERM position.

(10) Set the TRANSMIT OUTPUT switch to the 0 dB (DSX) position.

(11) Press the MODE switch to select T1 SLC mode.

(12) Connect the TRANSMIT connector of the T-BERD to the JACK PANEL's TRMTG LINE connector. Connect the RECEIVE connector to the JACK PANEL's RCVG LINE connector using WECO 310 cables.

(13) Press the RESTART pushbutton switch to begin the test.

(14) The following conditions should be observed:

(a) The T1 PULSES indicator is illuminated.
(b) The PATTERN SYNC indicator is illuminated.
(c) The FRAME SYNC indicator is illuminated.
(d) The B8ZS indicator is illuminated if clear channel (B8ZS) line coding is detected.

(15) Set the RESULTS 1 switch to the SIG & TIME position and scroll the RX FREQ result into Display 1.

(16) Verify that the frequency displayed is between 1543923 Hz and 1544077 Hz.

(17) Scroll the RX LEVEL (41) result into Display I and verify that the level shown is between -2 dBdsx and +2 dBdsx.

(18) Verify that none of the red alarm indicators are illuminated.

(19) Set the RESULTS I switch to the LOGIC position and scroll the BIT ERRORS result into Display I.

(20) Set the RESULTS II switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display II.

(21) If no bit errors or violations are detected, then both displays will show a result of 0. If bit errors and violations are detected, Display I will show a bit error count and Display II will show a violation count.

(22) With the RESULTS I switch still in the LOGIC position, scroll the SLIPS result into Display I. Verify that the SLIPS result is 0.

(23) If violations or frame errors were detected, the user may perform an end-to-end test using a second T-BERD 209 similarly configured at the far end of the span, either at the Central Office Terminal (COT) or the Remote Terminal (RT).

(24) To perform an end-to-end test, remove the pin plug from the F END LP position and insert it into the SW TO PROT position. This will allow the two T-BERDs to exchange data and permit further sectionalization of the failure.

4.5.2 In-Service Monitoring

The performance of a SLC-96 system can be monitored while in service for frame errors, bipolar violations, frequency, and level. To perform an in-service test, use the following procedure.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Press the MODE switch to select T1 SLC mode.

NOTE: The T1 D4 mode may be used for shelves B, C, and D, but T1 SLC mode MUST be used for the A shelf, otherwise, false frame errors may be counted.

(3) Set the TIME SET/TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(4) Set the RECEIVE INPUT switch to the DSX-MON position.

(5) Connect the LIU Test Cord (a 15-pin D to edge connector cable) from the LIU to the JACK PANEL.

(6) Connect the T-BERD 209 to the RCVG MONITOR jack of the JACK PANEL. If a T1 signal is present, the T1 PULSES indicator will be illuminated. The FRAME SYNC indicator will be illuminated when the framing pattern is detected.

(7) Press the RESTART pushbutton switch to begin the test.

(8) Set the RESULTS I switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display I.

(9) If no bipolar violations are detected, the display will show 0. If bipolar violations are detected, the display will show a violation count.

(10) Set the RESULTS II switch to the BPV & FRAME position and scroll the FRM ERRORS result into Display II. If no frame errors are detected, the display will show 0. If frame errors are detected, the display will show the frame error count.

(11) Set the RESULTS II switch to the SIG & TIME position and scroll the RX LEVEL result into Display II. Observe that the signal level is between -18 dBdsx and -22 dBdsx (a 20 dB loss is incurred due to the isolation resistors in the monitor jacks; if the jacks are not isolated, the level will be between -2 dBdsx and +2 dBdsx).

(12) Scroll the RX FREQ result into Display II and observe that the measured frequency is between 1543923 Hz and 1544077 Hz.

(13) The data being transmitted by the LIU can be monitored by plugging the T-BERD 209 into the TRMTG MONITOR JACK and repeating steps (9) through (12).

4.6 T1C TESTING

4.6.1 Out-of-Service Testing

To test the error performance of a T1C link, perform the following steps.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Press the MODE switch to select T1C mode.

(3) Press the PATTERN switch to select the 2^{20}-1 data pattern.

(4) Set the TIME SET/TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(5) Set the TIMING switch to the RECOV(LOOP) position if timing is to be recovered from the received data. Set the TIMING switch to the INT position if no timing source is present.

(6) Set the CODE switch to either the B8ZS or AMI position, as appropriate.

(7) Ensure that both of the ERROR INSERT switches (BPV and LOGIC) are in the OFF position (the switches are off when the LEDs within the switches are NOT illuminated). If an LED is illuminated, press the switch once to turn the LED and error insertion off.

(8) Set the RECEIVE INPUT switch to the TERM position.

(9) Connect the TRANSMIT and RECEIVE connectors to the circuit to be tested.

(10) Establish a loop at the far end of the circuit.

(11) Press the RESTART switch to begin the test once the loop is established.

(12) The following conditions should be observed.

(a) The T1C PULSES indicator is illuminated.

(b) The PATTERN SYNC indicator is illuminated.

(c) The B8ZS indicator will be illuminated if clear channel (B8ZS) line coding is detected.

(13) Set the RESULTS I switch to the SIG & TIME position and scroll the RX FREQ result into Display I. Verify that the frequency displayed is between 3151906 Hz and 3152094 Hz.

(14) Scroll the RX LEVEL (41) result into the display. Verify that the level shown is between -2 dBdsx and +2 dBdsx.

(15) Verify that none of the red alarm indicators are illuminated.

(16) Set the RESULTS I switch to the LOGIC position and scroll the BIT ERRORS result into Display I.

(17) Set the RESULTS II switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display II.

(18) If no bit errors and violations are detected, then both displays will show a result of 0. If bit errors or violations are detected, Display I will show a bit error count and Display II will show a violation count. If bit errors are being counted, but the violation count remains at 0, it is likely that errors are being introduced before the last repeatered span.

(19) With the RESULTS I switch still in the LOGIC position, scroll the SLIPS result into the display. Verify that the SLIPS result is 0.

4.6.2 In-Service Monitoring

To monitor a T1C circuit at a DSX patch bay without disrupting the T1C service, perform the following steps.

(1) Press the POWER switch to apply power to the T-BERD 209.

(2) Press the MODE switch to select T1C mode.

(3) Set the TIME SET TIMED TEST/CONTINUOUS TEST switch to the CONTINUOUS TEST position.

(4) Set the RECEIVE INPUT switch to the DSX-MON position. (Set the switch to the BRIDGE position if monitor jacks are not resistor isolated.)

(5) Connect one of the T-BERD 209's RECEIVE connectors to the MON jack on the DSX patch bay. If a T1C signal is present, the

T1C PULSES indicator will be illuminated. If the link being monitored is operating with clear channel (B8ZS) line coding, the B8ZS indicator will be illuminated.

(6) Press the RESTART switch to begin the test.

(7) Set the RESULTS I switch to the BPV & FRAME position and scroll the VIOLATIONS result into Display I. If no violations are detected, the display will show 0; if violations are detected, the display will show a violation count.

(8) Set the RESULTS II switch to the SIG & TIME position and scroll the RX LEVEL result into Display II. Observe that the signal level is between -18 dBdsx and -22 dBdsx (a 20 dB loss is incurred due to the isolation resistors in the monitor jacks; if the jacks are not isolated, the level will be between -2 dBdsx and +2 dBdsx).

(9) Scroll the RX FREQ result into Display II and observe that the measured frequency is between 3151906 Hz and 3152094 Hz.

4.7 TIMING SLIPS TESTING

Timing slips testing can be performed with the RS-232 Printer/Remote/Slips Interface (Model 30554). To test for timing slips between two T1 lines, perform the following steps.

(1) Install the RS-232 Printer/Remote/Slips Interface.

CAUTION: Always remove power from the T-BERD 209 before removing or inserting interfaces.

(2) Press the POWER switch to apply power to the T-BERD.

(3) Connect the Timing Reference line to the interface's WECO 310 jack, labeled T1-REF. This input will accept full DSX signals or DSX-MON point signals.

(4) Set the T-BERD 209's RECEIVE INPUT switch to the appropriate line termination position.

(5) Connect the RECEIVER input to the line under test.

(6) Press the MODE switch to select the appropriate T1 format.

(7) Set the RESULTS I switch to the SIG & TIME position and scroll the TIMING SLIP result into DISPLAY I.

(8) Set the RESULTS II switch to the SIG & TIME position and scroll the SLP ANA SEC result into Display II.

(9) Press the RESTART pushbutton switch to begin testing.

(10) If both the T1-REF and RECEIVER signals are present and are valid T1 signals, the SLP ANA SEC result will begin counting. This result will halt whenever either input is lost.

(11) The TIMING SLIP result will behave differently according to the timing relationships between the two signals.

(a) If both signals (T1-REF and RECEIVER) are perfectly synchronized, the TIMING SLIP count will remain at 0, the bar graph at center, and the wheel at top center. The wheel may move slightly to the right and left of center indicating natural wander or low-level jitter but, over the long-term, the wheel will remain at center.

(b) If the two signals are synchronized, but one of them has low-speed wander as seen with Doppler shifts from satellites (usually 20 to 30 bits over a period of 24 hours), the TIMING SLIP count will remain at 0. The bar graph and wheel will move right as the satellite gets closer (Blue shift) and left as the satellite moves farther away (Red shift). This movement would occur very slowly (over a matter of hours) as the display hovers about center.

(c) If the two signals are unsynchronized, and the RECEIVER frequency is higher than the T1-REF frequency, the wheel will move clockwise. The bar graph will move to the right. When the RECEIVER frequency is lower than the T1-REF frequency, the wheel will rotate counter-clockwise, and the bar will move to the left. The TIMING SLIP count will increment every 193 slips. If the frequency difference is more than a few cycles, the TIMING SLIP count will increment rapidly, and the bar graph and wheel will also move very rapidly.

SECTION 5
PRINTER/CONTROLLER INTERFACES

5.1 INTRODUCTION

Three optional printer interfaces are available for use with the T-BERD 209: the RS-232 Printer/Remote Control/Timing Slips Interface (Model 30554), the RS-232 Printer Remote Control Interface (Model 30505-01), and the RS-232 Printer Interface (Model 30505-02). All three of the interfaces permit the user to obtain printouts of results, alarm messages, and front panel setups; however, Models 30554 and 30505-01 provide the additional capability of remotely controlling the T-BERD 209 from a computer or dumb terminal. Sections 5.2 through 5.4 discuss the hardware and printing functions that are identical for Models 30554, 30505-01, and 30505-02. A detailed description of remote control capabilities (Models 30554 and 30505-01) begins with Section 5.5. A description of the timing slips measurement capability (Model 30554) begins with Section 5.8.

5.2 INTERFACE DESCRIPTION

The RS-232 connector on both interfaces is configured to function as Data Communications Equipment (DCE); it may be directly connected to Data Terminal Equipment (DTE). Connection to other DCE is possible with the use of an adaptor cable. This RS-232 connector is a 25-pin female D connector located below the DIP switches on the T-BERD's right side panel; the DIP switches are used to select the baud rate, parity, and line terminator.

Data is exchanged through the RS-232 interface in a serial asynchronous format with 1 start bit, 7 data bits, and an even or odd parity bit. Transmission always includes 2 stop bits; the T-BERD 209 can receive 1 or more stop bits. Data is encoded in the 7-bit American Standard Code for Information Interchange (ASCII) and operation is possible at 300, 1200, 2400, or 4800 baud. The line termination character provided at the end of each output line may be selected to be either a carriage return (CR) or a carriage return line feed (CRLF) sequence. Table 5-1 shows the selections available for configuring the RS-232 Printer Remote Control interface.

Table 5-1
RS-232 Printer/Controller
Interface Configurations

Baud rate:	300, 1200, 2400, 4800
Word length:	7 bits
Parity:	Even, odd, none
Line terminator:	CR, CRLF
Fast print:	Faster than 1 character per 10 ms
Slow print:	Fastest is 20 characters per 1 second

5.3 RS-232 PIN CONFIGURATION

To provide maximum operating flexibility, the use of the RS-232 signaling leads has been minimized. The interface monitors the Data Terminal Ready (DTR) line of the device to which it is connected. When this line is set true by the device, the T-BERD 209 assumes that the device is ready to accept a byte of data. The T-BERD asserts Clear To Send (CTS) true whenever it is ready to accept a byte of data from an external controller. Table 5-2 shows the RS-232 pin configuration.

Table 5-2
RS-232 Pin Configuration

PROT GND (Pin 1):	Connected to chassis ground.
TX DATA (Pin 2):	The T-BERD 209 receives data on this lead.
RCV DATA (Pin 3):	Data is transmitted by the T-BERD 209 on this lead.
RTS (Pin 4):	This lead is terminated by the T-BERD 209.
CTS (Pin 5):	This lead is driven to the ON state by the T-BERD 209 whenever it is ready to receive a command. This lead may be ignored by the controller if, before issuing commands, it waits for the return of a prompt character from the T-BERD signifying the completion of the previous command.
DSR (Pin 6):	This lead is driven to the ON state by the T-BERD 209 whenever it has power applied.
SIGNAL GROUND (Pin 7):	Connected to signal ground.
RLSD (Pin 8):	This lead is driven to the ON state by the T-BERD 209 whenever it has power applied.
SEC CTS (Pin 13) and SEC RCV DATA (Pin 16):	These leads provide + 12 (RS-232 ON) and -12 (RS-232 OFF) respectively, for use in strapping signaling leads ON and OFF.
DTR (Pin 20):	Data is output from the T-BERD 209 only when this line is held in the ON condition by the receiving device.

5.4 PRINTER OPERATION

Printouts are controlled by switches on the interface module's front panel. The PRINT switch has two momentary positions, RESULTS and CONTROLS, which select the type of printout to be generated. Results printouts and controls printouts are described in subsequent paragraphs. Pressing the PRINT switch to either position will immediately generate the appropriate printout.

The PRINT EVENT switch consists of a six-position electronic switch with up (▲) and down (▼) arrows and adjacent LED indicators that are illuminated to reflect the switch positions. The switch may be scrolled forward (▲) or backward (▼) through the switch positions; the LED indicators will be correspondingly illuminated. The switch positions and their functions are described below.

OFF—This position sends no data to the RS-232 connector and clears the printer FIFO (first-in, first-out memory). Results and controls prints are still available through the PRINT switch.

2 HR—This position initiates a results printout every 2 hours or if an alarm condition changes. (See Section 5.4.3.)

15 MIN—This position initiates a results printout every 15 minutes or if an alarm condition changes.

TEST END—This position initiates a results printout at the end of a timed test or if an alarm condition changes.

ERROR—This position initiates a results printout for each second on the occurrence of logical bit errors, CRC errors, frame errors, or bipolar violations, as well as if an alarm condition changes.

SEVERELY ERRORED SEC—This position initiates a results printout whenever the error rate exceeds 1×10^{-3} for that second or if an alarm condition changes.

NOTE: A 6-hour backup print is provided for both the ERROR and SEVERELY ERRORED SEC positions. The printout is labeled BACKUP PRINT and will occur only if the print criterion has not been satisfied for 6 hours.

The CLOCK SET switch has two momentary positions, MIN (DAT) and HR (MON). This switch permits the user to set the clock and calendar which comprise the CLOCK TIME and DATE results. These results are available only when either the Printer Interface option or the Printer Remote Control Interface option is installed.

When setting either the time or the date, the one that is being set must be displayed in one of the two results displays; the CLOCK SET switch has no effect if

it is pressed while neither the CLOCK TIME nor DATE result is being displayed. To set the time, scroll through the SIG & TIME category to display the CLOCK TIME result. To adjust the minutes, press up on the CLOCK SET switch; to adjust the hours, press down on the switch. To set the date, scroll through the SIG & TIME category to display the DATE result. To adjust the day, press up on the CLOCK SET switch; to adjust the month, press down on the switch.

A printer or a dumb terminal can be connected to the RS-232 printer interface. The print format is "list mode" so that the last line is at the top of the page. Each result or control message is 20 characters long, which means that in 80-column mode, each print line has four results (or messages). All printouts are time-stamped.

5.4.1 Results Print

The results print is available in two print formats: normal and short. The format is selectable via DIP Switch 7 on the T-BERD side panel. The normal printout includes all results available at the time the printout is initiated, while the short form includes only those results applicable to the current setting of the MODE switch. However, the short form also includes the two test results currently being displayed on the front panel even if they are not applicable to the current setting of the MODE switch. Both types of results prints will also list, under the heading ALARM STATUS, any alarm LEDs that are illuminated at the time the printout is initiated. Figure 5-1 is an example of normal results printout in 20-column format.

The results that are printed in the short form for each mode are listed below.

All Modes	D4 Framing	ESF
TIME and DATE	FRM ERR	CRC ERR
BPV	FRM ER RT	CRC ERR SEC
BPV SEC	FRM L CNT	FRM L CNT
BPV RT	FRM L SEC	FRM L SEC
SIG L SEC		
TEST SEC		
ALARMS		
BIT ERR *		
ERR SEC *		
BER *		
OUT SYN SEC *		
SLIPS *		

* These results are printed if pattern synchronization has been detected.

```
   RESULTS PRINT
02:56:16       7 OCT
BIT ERR          798
ASYN E SEC         6
BER        3.91 E-06
EFS              127
%EFS          94.78%
SY ERR SEC         4
OUT SY SEC         8
SLIPS              0
SES                8
%SES           5.84%
DEGR MIN           0
%DEGR MIN     00.00%
UNAVL SEC          0
%AVL         100.00%
CSES               1
BPV ERR         2411
BPV ER SEC         7
BPV RATE   1.17 E-05
CRC ERR            8
CRC ER SEC         5
FRA LOS            3
FRA LS SEC         8
CRC SES            8
CRC E RATE    2 E-04
FREQ Hz      1543993
RX LEVEL   +01 dBdsx
RX LEVEL     +17 dBm
SPX CUR UNDER 10 mA
SIG LS SC          5
ALARM SEC        137
TEST LEN    00:15:00
TEST SEC         137
TEST END        ****
ELAPS TIM   00:02:17
RX LVL    6.73 V p-p
   ALARM STATUS
PAT SYNC           ON
T1                 ON
FRM SYNC           ON
ALL ONE            ON
ALL ONE HIST       ON
EX ZERO HIST       ON
FRM LOS HIST       ON
PAT LOS HIST       ON
SIG LOS HIST       ON
```

Figure 5-1

Normal Results Print

A results print can be initiated manually, by pressing the PRINT switch to the RESULTS position, or automatically via the PRINT EVENT switch. A results print is also automatically initiated by a result counter overflow and is labeled OVERFLOW PRINT; the printout will also state the reason for the overflow. Each time a result counter overflows, the overflowed result is preceded on the printout by a double asterisk (**). This indicates a "just now overflowed" condition, which means that the result count overflowed in the last second. Subsequent printings of the overflowed result are preceded by a single asterisk (*) to indicate a "previously overflowed" condition. All asterisks are cleared at test restart.

5.4.2 Controls Print

The controls printout lists the current position of all of the front panel switches as well as the side panel DIP switches that are in non-standard positions. A controls print is initiated by pressing the PRINT switch to the momentary CONTROLS position. Figure 5-2 is an example of a controls printout.

```
  CONTROLS PRINT
02:55:37     7 OCT
MODE:            AUX
PATTERN:  ALL ONES
TIMED/CONT:    CONT
DIS HOLD:       OFF
TIMING:         INT
CODE:           AMI
ERR INS BPV:    OFF
ERR INS LOG:    OFF
RCV INPUT:     TERM
TX LBO:         0dB
PRI EVNT:       OFF
CONT/HALT:     HALT
CSU/FAC/PGM:    CSU
IMB/OVE: OVERWRITE
RESPONSE:      AUTO
PARITY:        EVEN
BAUD RATE:     2400
CR/CR-LF:        CR
FORMAT:      NORMAL
COLUMN:          20
```

Figure 5-2

Controls Print

5.4.3 Alarm Messages

When the PRINT EVENT switch is not set to OFF, alarm messages are initiated automatically to inform the user of an important development with the ongoing test. When any alarm condition changes, a single alarm message is printed out at once. This is true for all alarm conditions except PATTERN LOSS, YELLOW ALARM, EXCESS ZEROS, and ALL ONES. With these four conditions, their status is checked at the end of each second and if any have changes, a single alarm message is printed for each prior to the ALARM CHANGE printout. If at the end of each test second at least one alarm condition changed, the entire results will be printed out under the label ALARM CHANGE PRINT. The events that trigger alarm conditions are discussed in Section 2 (Functional Description). The format for an alarm message is:

[alarm message name]
[time date]

Alarm messages can be categorized as follows:

(1) ALL ONES, EX ZERO, YELLOW ALM—These alarm messages are followed by either ON or OFF to indicate their status. EX ZERO is not applicable with the 2^{20}-1 or 2^{23}-1 patterns.

(2) PATT LOSS, FRAM LOSS, SIG LOSS—These alarm messages are followed by a count of the number of such occurrences during the test.

(3) PATT SYNC ACQUIRED, FRA SYNC ACQUIRED—These messages are printed out when synchronization is acquired.

(4) TEST COMPLETE—When in Timed Test mode with the PRINT EVENT switch in a position other than the TEST END position, this message is printed when a timed test is completed, rather than printing an entire results print.

(5) TEST RESTART—This message is initiated by pressing the TEST RESTART switch or any of the major switches.

(6) NEW CONFIGURATION—This message indicates a major switch change.

NOTE: Major switches include: PATTERN, MODE, RESTART, POWER, TIMING, RECEIVE INPUT, HALT CONTINUE, and NO RESPONSE AUTO RESPONSE.

(7) LOOP DOWN DETECT, LOOP UP DETECT, TLB DETECT, LLB DETECT, SIGNAL DETECT, LOOP DOWN LOSS, LOOP UP LOSS, TLB LOSS, LLB LOSS -These messages indicate that a certain condition has either been detected or lost.

(8) LOOP DN DURA, LOOP UP DURA—This message indicates the duration time of loop-code transmission. Duration time is the number of seconds from the time loop up (or loop down) starts until it stops.

(9) BUFFER FULL—This message is printed when the print buffer has overflowed. When the print buffer is full, some information may be lost.

5.5 CONTROLLER INTERFACE DESCRIPTION

5.5.1 Command Formats

The Printer/Remote Control Interface (Model 30505-01) and the Printer/Remote/Slips Interface (Model 30554) include (1) switch commands which control the instrument switch settings, and (2) control commands which pertain exclusively to the printer/controller interface. All switches (except the POWER switch and the parity and baud rate DIP switches) can be remotely controlled. Commands sent to the T-BERD use the ASCII format and must be followed by a terminating character (CR or CRLF sequence). All non-terminating characters sent before the terminator are treated as part of a command. As characters are received, they are placed in a buffer until the reception of a terminator. If the 512-character buffer fills before a terminator is received, a command buffer overflow error is generated and additional bytes received are discarded.

Reception of a backspace (08H) causes the last received character to be discarded. Reception of a Control C (03H) or ETX causes the print buffer to be cleared and the command buffer to be emptied. A Control X (18H) or CANCEL simply clears the command buffer. All space (20H) and null (00H) characters are discarded, and commands may be entered in either uppercase or lowercase letters.

Each command consists of a string of ASCII characters which represent a command, a selected parameter, or a switch position selection. In some cases, the command consists of a single string, such as the FORMAT command. In other cases, the command consists of two strings; for example, MOD T1, where MOD represents the MODE switch and T1 represents the switch position. If the T-BERD does not recognize a character sequence when it is removed from the buffer, a syntax error is generated. Provided that no errors occur (including parity, overrun, or framing errors), the T-BERD decodes the character sequence, generates the appropriate response, and prepares for another input sequence.

Upon reception of a valid command, the T-BERD 209 exits Local Control (front panel) mode and enters Remote Control mode. While under remote control operation, the front panel switches (except for the CATEGORY and RESULTS switches) are disabled.

5.5.2 Switch Commands

Switch commands are mnemonics that represent the first three characters of the switch name or switch position as it appears on the T-BERD front panel and in the display. Exponents are lowered to become the last digit of the number; for example, 10^{-6} becomes 10-6. Table 5-3 lists the switch command mnemonics and the corresponding switch names. Brackets to the right of the switch mnemonic indicate that there are additional parameters for that command; these parameters are listed in full for each command in Section 5.7.

Table 5-3
Switch Command Mnemonics

Front Panel Switches

Switch Mnemonic	Switch Name
COD [ ]	CODE
CON TES	CONTINUOUS TEST
DIS HOL [ ]	DISPLAY HOLD
ERR INS BPV [ ]	ERROR INSERT BPV
ERR INS LOG [ ]	ERROR INSERT LOGIC
HIS RES	HISTORY RESET
LOO DOW [ ]	LOOP DOWN
LOO UP [ ]	LOOP UP
MOD (mode)	MODE
PAT (pattern)	PATTERN
PRI [ ]	PRINT
PRI EVE (event)	PRINT EVENT
REC INP [ ]	RECEIVE INPUT
RES 1 (result #)	RESULTS I
RES 2 (result #)	RESULTS II
RESTART	RESTART
TIM [ ]	TIMING
TIM SET hhh:mmm	TIME SET
TIM TES	TIMED TEST
TRA OUT [ ]	TRANSMIT OUTPUT

Switch Mnemonic	Switch Name
AUTO RESPONSE	AUTO RESPONSE (DIP Switch 10)
CON	HALT/CONTINUOUS (DIP Switch 1)
CSU CODE	CSU/FACILITY (DIP Switch 9)
FAC CODE	CSU/FACILITY (DIP Switch 9)
HAL	HALT/CONTINUOUS (DIP Switch 1)
IMB	IMBED/OVERWRITE (DIP Switch 2)
NO RESPONSE	NO RESPONSE (DIP Switch 10)
NORMAL	NORMAL/SHORT (DIP Switch 7)
OVE	IMBED/OVERWRITE (DIP Switch 2)
SHORT	SHORT/NORMAL (DIP Switch 7)
WIDTH	20/80 DIP SWITCH (DIP Switch 8)

To change a switch position, the user enters the switch name mnemonic followed by the mnemonic for the desired switch position. If the user enters only the switch name mnemonic, the T-BERD will return the current switch setting. The front panel displays may be controlled via remote control with the [RES n result-name] command, where "n" is 1 or 2 corresponding, respectively, to Display I and Display II. The RESULTS I and II switches can also be enabled for local control (while still under overall remote control operation) with the DISPLAY command. The list of remote control commands in Section 5.7 includes the switch mnemonics and the selectable switch position mnemonics. The T-BERD 209 also provides an on-line HELP feature; entering HELP will return the list of commands. Entering [HELP command-name] returns a list of parameters for that particular command.

5.5.3 Control (Non-Switch) Commands

Remote control provides a number of commands which have no front panel equivalent. These commands are used to obtain information from the T-BERD or to modify the controller interface protocol. Table 5-4 lists these commands; the list of remote control commands in Section 5.7 provides a detailed description for each of them.

Table 5-4

Control Command Mnemonics

ALARM	LEDS
CLEAR FIFO	LOCAL
CLOCK	PGM CODE
CLS	PGM LPDN
DATE	PGM LPUP
DEVICE CLEAR	PGM PAT 1
DISPLAY	PGM PAT 2
ECHO	PRINT
FAST	PROMPT
FIRST P.U.	REL
FORMAT	REMOTE
HELLO	SLOW
HELP	TERM 232
HELP (command name)	TERMINAL
HOLD	UNFORMAT

5.6 CONTROLLER INTERFACE OPERATION

The T-BERD enters remote control operation when the printer controller interface receives a valid command. While under remote control, all front panel switches (except the CATEGORY and RESULTS I and II switches) are disabled and the message UNDER RS-232 REMOTE CONTROL is flashed periodically in the display.

Commands are checked for validity as they are processed. If a command is found to be in error, a syntax error message is returned to the printer/controller interface. If the command is valid and the PROMPT feature is enabled, a prompt is returned.

Once the first valid command is received, the T-BERD 209 remains in remote control until reception of the LOCAL command or until a power-up occurs. When the T-BERD is returned to LOCAL (front panel) control, it performs a scan to update the front panel switches and restarts the test. Only fixed-position switches, such as the TIMING switch, are updated to reflect their manually set positions. The momentary-position switches, such as the MODE switch, retain the settings they had upon leaving remote control. If PRINT EVENT is set to TIM in remote control, it will be OFF when the T-BERD is returned to local control.

5.6.1 Input Sequence

A typical controller input sequence would occur as follows:

(1) The controller sends the T-BERD 209 an ASCII character which is the first part of a command sequence. Upon reception of this character,

the T-BERD automatically executes a temporary printer HOLD command. This command halts any ongoing printer outputs at the end of the outgoing line. Data may continue accumulating in the printer buffer, but no data will leave the buffer until a command terminator is received by the T-BERD.

(2) The T-BERD 209 places the received character into its command input buffer. If the ECHO feature is enabled, the character is echoed back to the controlling device.

(3) Additional non-terminator characters are received. Null characters are discarded. All other characters except backspace (BS), ETX (Control C), and CANCEL (Control X) are placed in the command input buffer for storage until a terminator is entered. If the ECHO feature is enabled, each printable character is echoed back to the controlling device. All control characters (other than CR, LF, BS, and Control C and X) are echoed as a period (2CH). This allows a terminal operator to see a control character represented on the screen as a dot and to use the backspace key to eliminate it or previous entries. When the T-BERD receives a BS character, the BS character is echoed and the most recently input character is discarded.

(4) The controller sends the T-BERD 209 one of the terminators: CR, LF or CRLF sequence, as selected.

(5) The T-BERD 209 recognizes that a terminator has been received and processes the command.

If either the PROMPT or ECHO feature is enabled, the selected terminator is echoed to the controlling device as a terminator response. Upon terminator reception, the T-BERD 209 analyzes the data in its input buffer. If any of the following — UART input overrun, parity error, framing error, input buffer overflow, or syntax error—is detected, the appropriate error message is returned to the controller. If no errors are detected, the command is decoded and the appropriate response generated.

If the PROMPT feature is enabled, the prompt character ">" (3EH) is the last character transmitted to the controller. It signifies that the command sequence has been received and processed, that any error messages associated with that command have been sent, and that the T-BERD is ready for additional commands. Some controllers may not be capable of watching for the prompt character to determine when the T-BERD is prepared to accept additional commands. After sending a terminator following a command sequence, these controllers should wait approximately 200 ms to verify that the T-BERD data outputs are completed before sending additional commands. The 200 ms waiting time is adequate for most commands. The purpose of having a controller wait for a prompt, or to wait long enough to ensure that the T-BERD is ready, is to prevent output buffer overflows. If the T-BERD 209 receives an additional command before its output buffer is empty, the buffer contents may be overwritten and error messages could be lost or associated with the wrong command.

5.6.2 Output Sequence

Outputs can be divided into two categories: those which pass through the printer buffer and those which come from the auxiliary output buffer. Data output from the printer buffer occurs whenever (1) the buffer contains data, (2) no HOLD command has been issued, and (3) the Clear To Send (CTS) line is in the ON (true) condition. The outputs continue sequentially until one of the above conditions is not true. If the CTS input is turned OFF (false) during an output, the output stops and eventually resumes when the CTS is turned ON again. This line is checked before transmitting each character. If the HOLD command is received, the output stops after the next sequential terminator is output. Once the REL (release) command is received, the output resumes from where it left off.

When characters are received through the RS-232 Printer/Remote Controller Interface, a temporary HOLD is automatically executed. Output from the auxiliary output buffer occurs if either the ECHO or PROMPT feature is enabled or if an error message is generated. For output to start, the CTS line must be ON and any ongoing printer output must have stopped. Once the auxiliary output buffer is empty, the normal printer outputs may continue.

5.6.3 Error Messages

Most error messages contain the prefix ERROR and are terminated by a CR or CR/LF sequence, as selected. The following is a list of the possible error messages.

ERROR: Characters after statement end.
The T-BERD 209 found additional characters following what it thought was the end of a valid command.

ERROR: Command buffer overflow.
Either the user sent a command that was greater than 512 characters in length or sent too many commands too fast.

ERROR: Illegal delimiter.
A delimiter (",", ":", etc.) was expected in the command, but none was found.

ERROR: Illegal value.
The value supplied with the command is not within the valid range of the requested function.

ERROR: Receiver framing error.
The T-BERD 209 detected one or more asynchronous framing errors in the input command. This may occur if the controller's data format is different from that of the T-BERD.

ERROR: Receiver overrun error.
The controller is sending characters to the T-BERD 209 while the Clear To Send (CTS) control signal is OFF (false) indicating that the T-BERD is not ready for more data. The solution is to respond to signaling.

ERROR: Receiver parity error.
The T-BERD 209 received one or more characters in the command with a parity error.

ERROR: Unrecognized command.
The T-BERD did not recognize the command name entered in the command line.

ERROR: Unrecognized parameter.
The T-BERD recognized the requested command, but could not interpret the specified command parameter.

RESULT UNAVAILABLE.
The user has requested a result whose value cannot yet be computed. This may occur when the T-BERD is out of frame or pattern synchronization and a result was specified that is only available when the T-BERD is in frame or pattern synchronization.

NOT APPLICABLE TO MODE
The T-BERD is in a mode in which the requested result is not applicable.

5.7 REMOTE CONTROL COMMANDS

This section presents all of the remote control commands in alphabetical order. Each command is listed on a separate page; for ease of location, the command name appears in both the upper-left and upper-right corner of each page. For each command there is an explanation of the command, references to associated commands, and a brief example of command usage. Bold characters are used throughout this section to indicate the commands themselves as well as variables to be entered with the commands.

Alarm Message Prints

ALARM :Print the alarm printout status
ALARM [ON / OFF] :Enable or disable alarm message prints

This command sets or returns the alarm printout status. It allows the user to enable or disable the printout of alarm messages (alarm messages are explained in Section 5.4.3. When the **ON** selection is chosen, alarm messages will be printed. When the **OFF** selection is chosen, alarm messages will not be printed. When the **PRI EVE** command is **OFF**, the **ALARM ON** command has no effect because no printouts are enabled.

EXAMPLE:

```
>ALARM OFF          :disable alarm message prints
>ALARM              :print the current alarm status
 OFF
```

Activate Automatic Response to Loop Codes

AUTO RESPONSE

This command activates the **AUTO RESPONSE** mode. When the T-BERD 209 is in Automatic Response mode, it acts as a CSU in response to the reception of loop codes. If 5 seconds of in-band loop-up codes are received, the T-BERD will automatically save its current MODE and enter Line Loopback (AUTO LLB) mode. The T-BERD 209 then repeats via the transmitter all data received. Subsequently, the reception of a proper loop-down code sequence will cause the T-BERD to exit AUTO LLB mode and return to the previous MODE.

The out-of-band loop code will be declared immediately upon its detection. The receive line loopback (LLB) code and receive test loopback (TLB) codes are detected with Pins 7 and 8 of the 15-pin D connector. When either of these out-of-band loop codes is detected, the T-BERD will automatically save its current MODE and enter the appropriate AUTO TLB or AUTO LLB mode for as long as the code is detected.

If **AUTO RESPONSE** is active and the T-BERD 209 MODE is set to T1C, T1 TLB, or T1 LLB, when a loop code is detected, the T-BERD will respond only by illuminating the LOOP UP or LOOP DOWN receive indicators. It will not enter AUTO LLB mode.

The detection of in-band loop codes is directly affected by the selection of CSU loop codes or facility loop codes, because this selection determines the patterns that the T-BERD receiver will recognize as a loop code. See **CSU CODE** and **FAC CODE.** The **AUTO RESPONSE** feature will not respond to programmable loop codes.

Entering **AUTO RESPONSE** causes a test restart. The alternative to **AUTO RESPONSE** is **NO RESPONSE**.

EXAMPLE:

```
>AUTO RESPONSE          :activate automatic response to loop codes
>
```

Clear the Print FIFO

CLEAR FIFO

This command clears the print FIFO (First-In, First-Out memory) of all printouts that were awaiting printing.

EXAMPLE:

```
>CLEAR FIFO                    :clear the print FIFO
>
```

Clock Time

CLOCK :Print the clock time (time of day)
CLOCK hh:mm :Set the clock time

This command sets or returns the clock time. The time is entered in 24-hour format; the seconds are always set to zero when a new time is entered.

EXAMPLE:

```
>CLOCK                  :print the clock time
 15:30                  :(3:30 p.m.)
>CLOCK 6:28             :set clock time to 6:28 a.m.
>
```

Clear the Terminal Screen

CLS

This command causes the T-BERD 209 to output 30 of the selected line terminator sequences (usually CRLF for terminals) to the terminal. This has the effect of clearing the terminal screen of all previous outputs.

EXAMPLE:

```
> CLS                    :clear the terminal screen
                         :30 line terminators transmitted
  .
  .
  .
>
```

Select Code Type

COD	:Print the current code status
COD [AMI / B8Z]	:Set the code type

This command selects or returns the current code type used by the T-BERD 209 transmitter. B8ZS decoding is always available on the receive side. When the AMI selection is chosen, **AMI** coding is enabled. When the B8Z selection is chosen, **B8ZS** coding is enabled.

EXAMPLE:

>**COD**	:print the current COD status
AMI	
>**COD B8Z**	:enable B8ZS coding
>	

Continuous Error Counting

CON

This command selects the continuous counting of errors and slips throughout a loss of pattern synchronization. The alternative is the halt (**HAL**) method of freezing all LOGIC results when a pattern synchronization loss occurs and restarting them when pattern synchronization is reacquired. This command causes a test restart.

EXAMPLE:

```
>CON                    :select continuous error counting
>
```

Continuous Test

CON TES

This command selects a continuous test to be performed as opposed to a timed test (**TIM TES**). A continuous test is one of unlimited duration.

EXAMPLE:

```
>CON TES                    enter continuous test mode
>
```

Select CSU Loop Codes

CSU CODE

This command selects CSU loop codes for use by the T-BERD 209 transmitter and receiver. The CSU loop-up code is 10000; the loop-down code is 100. When **CSU CODE** is selected, the T-BERD transmits the codes when either the **LOOp UP** or **LOOp DOWN** command is turned ON. These codes will also then be the patterns that the T-BERD 209 receiver will detect as loop codes. The alternatives are **FAC**ility **CODE**s, and **PGM CODE**s.

This command is activated in hardware immediately upon its reception. If the T-BERD 209 is set to **FAC CODE a**and is receiving a CSU loop-up code, the pattern will not be recognized as a loop-up code. If the user selects CSU CODE while the pattern is still being received, the T-BERD 209 receiver will then recognize the received loop-up code as such.

See also **AUTO RESPONSE** and **NO RESPONSE.**

EXAMPLE:

>**CSU CODE** :selects CSU loop codes

Calendar Date

DATE Print the date
DATE dd/mm :Set the date

This command sets or returns the date (day and month only).

EXAMPLE:

```
>DATE                    :print the date
  4 SEP
>DATE 18/5               :set date to May 18
>
```

Clear Device

DEVICE CLEAR

This command clears the T-BERD 209 by executing the power-up procedure. The entire instrument is reinitialized—hardware and RAM.

NOTE: The user will no longer be in remote control after this command is executed.

EXAMPLE:

```
>DEVICE CLEAR          :execute instrument power-up
                        (no longer in remote control)
```

Display Hold

DIS HOL :Print display hold status
DIS HOL [ON /OFF] :Enable or disable display hold

This command sets or returns the display hold mode. If the **DIS HOL ON** selection is chosen, the T-BERD 209's displayed results (accessed through the **RES 1** and **RES 2** commands) are frozen in their current state. Otherwise, with the **DIS HOL OFF**, the displayed results are constantly updated to reflect the current values. While **DIS HOL** is **ON**, any results accessed from remote control are the current values rather than the values being held in the display.

EXAMPLE:

>**DIS HOL** :print the DIS HOL status
OFF
>**DIS HOL ON** :enable display hold mode
>

Front Panel Display Mode

DISPLAY :Print the display status
DISPLAY [LOCAL / REMOTE]:Set the front panel display mode

This command sets or returns the display control status. It permits the remote controller to determine whether or not the front panel display switches will be active while the T-BERD is under remote control. If the **DISPLAY LOCAL** selection is made, the four result display switches will remain operative while the T-BERD is in remote control (allowing the user to scroll through all of the results). On the other hand, the **DISPLAY REMOTE** selection disables the front panel display switches (along with all others) allowing only the remote controller to manipulate the displayed results (via the **RES 1** and **RES 2** commands). **DISPLAY LOCAL** is automatically set upon entering remote control mode.

EXAMPLE:

```
>DISPLAY                    :print the display status
 REMOTE
>DISPLAY LOCAL              :enable front panel control of display
>
```

Remote Control Command Echo

ECHO :Print the echo function status
ECHO [ON / OFF] :Enable or disable echo mode

This command sets or returns the remote control command echo mode. It determines whether or not the T-BERD will echo characters received from the controller. If the **ECHO OFF** selection is chosen, no received characters will be echoed. Otherwise, with the **ECHO ON** selection, all received characters will be echoed.

EXAMPLE:

```
>ECHO                    :print the ECHO status
  ON
>ECHO OFF                :disable the echoing of characters
>
```

Insertion of BPV Errors

ERR INS BPV :Print status of BPV error insert
ERR INS BPV [OFF / 10-6] :Enable or disable constant BPV error rate
ERR INS BPV SIN :Insert single BPV error

This command sets or returns the BPV error insertion rate. Selecting **ERR INS BPV 10-6** causes one error to be injected into the generated data for every 1,000,000 bits. Selecting **ERR INS BPV OFF** terminates this condition. The **ERR INS BPV SIN** command causes a single BPV error to be inserted into the generated data. Note that a single error insertion will also terminate a 10^{-6} error insertion rate.

EXAMPLE:

```
>ERR INS BPV OFF          :turn off the BPV error insertion rate
>ERR INS BPV              :print the BPV error insertion status
 OFF
>ERR INS BPV 10-6         :activate 10^-6 BPV error insertion rate
>ERR INS BPV SIN          :insert a single BPV error
>ERR INS BPV              :print BPV error insertion status
 OFF                      :note that the SIN command turned it off
>
```

Insertion of Logic Errors

ERR INS LOG	:Print status of logic error insert
ERR INS LOG [OFF / 10-6]	:Enable or disable constant logic error rate
ERR INS LOG SIN	:Insert single logic error

This command sets or returns the logic error insertion rate. Selecting **ERR INS LOG 10-6** causes one error to be injected into the generated data for every 1,000,000 bits without regard to whether a bit is a data bit or a framing bit. Selecting the **ERR INS LOG OFF** terminates this condition. The **ERR INS LOG SIN** command causes a single logic error to be inserted into the generated data. Note that a single error insertion will terminate a 10^{-6} error insertion rate.

EXAMPLE:

```
>ERR INS LOG OFF          :turn off the logic error insertion rate
>ERR INS LOG              :print the LOG error insertion status
  OFF
>ERR INS LOG 10-6         :activate 10-6 logic error insertion rate
>ERR INS LOG SIN          :insert a single logic error
>ERR INS LOG              :print logic error insertion status
  OFF
>
```

Select Facility Loop Codes

FAC CODE

This command selects facility loop codes for use by the T-BERD 209 transmitter and receiver. The facility loop-up code is 1100; the loop-down code is 1110. When **FAC CODE** is selected, the T-BERD 209 transmits the codes when either the **LOOp UP** or **LOOp DOWn** command is turned ON. These codes will then also be the patterns that the T-BERD 209 receiver will detect as loop codes. The alternatives are **CSU CODE**s, and **PGM CODE**s.

This command is activated in hardware immediately upon its reception. If the T-BERD 209 is set to **CSU CODE** and is receiving a facility loop-up code, the pattern will not be recognized as a loop-up code. If the user selects **FAC CODE** while the pattern is still being received, the T-BERD 209 receiver will then recognize the received loop-up code as such.

See also **AUTO RESPONSE** and **NO RESPONSE**.

EXAMPLE:

```
>FAC CODE                    :selects facility loop codes
>
```

Fast Print Speed

FAST

This command selects the fast print speed (as fast as the T-BERD can print) for the RS-232 interface. The alternative to **FAST** is the **SLOW** command.

EXAMPLE:

```
>FAST                    :activate fast print
>
```

First Power-Up

FIRST P.U. :Resets NOVRAM to factory settings

This command reloads factory settings into NOVRAM locations. The user remains in remote control after this command is executed.

EXAMPLE:

```
>FIRST P.U.          :reload NOVRAM with factory settings
>                    :note that the user remains in remote control
```

Format Printouts

FORMAT :Selects formatted printouts

This command enables the printing of blanks in printouts to make it easier for the human controller to read. The alternative is **UNFORMAT**, which is more desirable for the computer controller. Formatted printouts are automatically selected upon entering remote control and upon leaving remote control with the **LOCAL** command.

Sample Formatted Print

```
PATTERN:     3 IN 24
MODE:             T1
13:41:57     24 OCT
  CONTROLS PRINT
```

EXAMPLE:

>**FORMAT** :enable printing of blanks in printouts

>

Halt Error Counting

HAL :Halts error counting on sync loss

This command selects the halting of error and slip counting throughout a loss of pattern synchronization. All LOGIC results are frozen when a pattern synchronization loss occurs and are restarted when pattern synchronization is reacquired. The other alternative is the continuous (**CON**) method of continuing the counting of errors and slips throughout the synchronization loss. This command causes a test restart.

EXAMPLE:

>**HAL** :select halt mode on sync loss
>

Display T-BERD 209 Software Revision Level

HELLO

This command causes the T-BERD 209 to return to the terminal the revision level of its software.

EXAMPLE:

```
>HELLO                          :display the software revision level
  T-BERD 209, Software Rev Z, (c) TTC, 10 Sep 1999
>
```

On-Line Help Function

HELP :Display list of all commands
HELP (command name) :Display the parameter syntax for a command

This command provides the remote user with access to the T-BERD on-line help features. The main help screen shows the user a list of all remote control commands. Entering **HELP (command name)** causes the T-BERD to print a list of all possible parameters associated with the specified command.

EXAMPLE:

```
>HELP                    :print the main help screen
.
.
.
>HELP DIS HOL            :print list of parameters for the DIS HOL command
  ON
  OFF
>
```

History Reset

HIS RES :Clear history LED indicators

This command clears all of the history LED indicators in the upper right corner of the T-BERD 209 front panel.

EXAMPLE:

>**HIS RES** :clear history LED indicators
>

Hold All Printer Outputs

HOLD

This command causes the T-BERD to temporarily hold all printer outputs (in the print FIFO) until reception of a release (**REL**) command. Printout data can be added to the print FIFO while a **HOLD** is in progress, but it will not be printed until the release command is entered.

EXAMPLE:

```
>HOLD                    :hold all printouts
>
```

Imbed Framing in Loop Codes

IMB

This command causes frame and loop code bits to be interleaved. It is only active while transmitting loop codes in T1 D4, T1 ESF, and T1 SLC modes; however, the command can be used at any time to select this option in preparation for its future use. The alternative command is **OVE**rwrite.

EXAMPLE:

```
>IMB                    :imbed framing in loop codes
>
```

Print the State of the Front Panel LED Indicators

LEDS

This command causes the T-BERD to print the names of the front panel status LED indicators (current and history) that are illuminated at the time that the command is received. The indicators include:

ALL ONES	T1 PULSES
B8ZS DETECT	T1C PULSES
EXCESS ZEROS	TLB RECEIVE
FRAME LOSS	YELLOW ALARM
FRAME SYNC	
LLB RECEIVE	ALL ONES HISTORY
LOOP DOWN RECEIVE	EXCESS ZEROS HISTORY
LOOP UP RECEIVE	FRAME LOSS HISTORY
PATTERN LOSS	PATTERN LOSS HISTORY
PATTERN SYNC	POWER LOSS HISTORY
PRE-EXIST LOOP	SIGNAL LOSS HISTORY
SIGNAL LOSS	YELLOW ALARM HISTORY

EXAMPLE:

```
>LEDS                    :print list of LED indicators currently active
  EXCESS ZEROS HIST
  T1 PULSES
  PATTERN SYNC
```

Return T-BERD to Local Mode

LOCAL

This command causes the T-BERD to return to local mode from remote mode, making the front panel switches active again. The T-BERD will remain in local mode until it receives a valid remote control command from the controller. Formatted printouts are activated automatically with the **LOCAL** command. This command causes the front and side panel switches to be updated and a test restart to occur.

EXAMPLE:

```
>DATE 30/10          :set date and enter remote mode
>LOCAL               :return to local (front panel) mode
```

Generate Loop-Down Code

LOO DOW :Print status of loop-down code
LOO DOW [ON / OFF] :Enable or disable loop-down code transmission

This command sets or returns the loop-code transmission status. When the **ON** selection is chosen, loop-down code transmission is activated. When the **OFF** selection is chosen, the transmission of the loop-down code (if active) is halted. The transmission of the loop-down code will continue until it is no longer detected at the T-BERD 209's receiver or until the **LOO DOW OFF** command is issued. The type of loop-down code transmitted depends on whether CSU, Facility, or programmable loop-down codes have been selected. The CSU loop-down code is 100; the Facility code is 1110. The programmable code can be any 3- to 8-bit sequence as set using the **PGM LPDN** command. The CSU or Facility codes are selected by the **CSU CODE** and **FAC CODE** commands or via the CSU/FACILITY DIP switch.

EXAMPLE:

```
>LOO DOW                    :print status of loop-down code
  OFF
>LOO DOW ON                 :activate loop-down code transmission
>
```

Generate Loop-Up Code

LOO UP :Print status of loop-up code
LOO UP [ON / OFF] :Enable or disable loop-up code transmission

This command sets or returns the the loop-up code transmission status. When the **ON** selection is chosen, loop-up code transmission is activated. When the **OFF** selection is chosen, the transmission of the loop-up code (if active) is halted. Transmission of the loop-up code will continue until it is detected at the T-BERD 209's receiver for 250 ms or until the **LOO UP OFF** command is issued. The type of loop-up code transmitted depends on whether CSU, Facility, or programmable loop-up codes have been selected. The CSU loop-up code is 10000; the Facility code is 1100. The programmable code can be any 3- to 8-bit sequence as set using the **PGM LPUP** command. The CSU or Facility codes are selected by the **CSU CODE** and **FAC CODE** commands or via the CSU/FACILITY DIP switch.

EXAMPLE:

```
>LOO UP                    :print status of loop-up code
 OFF
>LOO UP ON                 :activate loop-up code transmission
>
```

Transmit and Receive Mode

MOD :Print status of mode
MOD (mode) :Select a mode

This command sets or returns the current transmit and receive line rate and data format. The (**mode**) selected may be one of the following.

T1	:T1 line rate unframed
T1 D4	:T1 rate with D4 framing
T1 ESF	:T1 rate with ESF framing
T1 SLC	:T1 rate with SLC-96 framing
T1C	:T1C line rate
T1C TLB	:T1C rate in Test Loopback mode
T1 TLB	:T1 rate in Test Loopback mode
T1 LLB	:T1 rate in Line Loopback mode
SEL TST	:Self-Test mode using T1 ESF

EXAMPLE:

```
>MOD                    :print status of mode
  T1 SLC
>MOD T1 ESF             :set mode to T1 rate with ESF framing
>
```

Deactivate Automatic Response to Loop Codes

NO RESPONSE

This command deactivates the **AUTO RESPONSE** mode so that the T-BERD 209 will not automatically respond to the reception of loop codes. Entering **NO RESPONSE** causes a test restart. The alternative is **AUTO RESPONSE**.

EXAMPLE:

```
>NO RESPONSE              :do not automatically respond to loop codes
>
```

Normal Results Print Format

NORMAL

This command selects the normal format for results prints. The normal format includes all results available at the time the printout is initiated regardless of the current mode. The other results print format offered is **SHORT**.

EXAMPLE:

```
>NORMAL                    :select normal (long) format
>
```

Overwrite Loop Code Bit With Frame Bit

OVE

This command causes a loop-code bit to be replaced by a frame bit every 193 bits. Overwriting is only active while transmitting loop codes in T1 D4, T1 ESF, and T1 SLC modes. However, this command can be used at any time to select this option in preparation for its future use. The alternative command is **IMB**ed.

EXAMPLE:

```
>OVE                    :overwrite framing onto loop codes
>
```

Generator Data Pattern

PAT	:Print status of pattern
PAT (pattern)	:Select data pattern

This command sets or returns the current data pattern generated by the T-BERD. The (pattern) selection may be one of the following.

ALL ONE	:All Marks
1:1	:Alternating Mark and Space
1:7	:One Mark and seven Spaces
3 IN 24	:1000 1000 1000 0000 0000 0000
T1-QRS	:QRSS pattern (2^{20}-1 with zero suppression)
T1C QRS	:2^{20}-1 pseudorandom
2^15-1	:2^{15}-1 bit pseudorandom
2^20-1	:2^{20}-1 bit pseudorandom
2^23-1	:2^{23}-1 bit pseudorandom
pgmpat-name:	User-defined pattern; factory setting is USER for a 1:3 pattern

EXAMPLE:

>**PAT**	:print status of pattern
QRS	
>**PAT 2^15-1**	:select new pattern

Select Programmable Loop Codes

PGM CODE

This command selects 3- to 8-bit user-programmable loop codes for use by the T-BERD 209 transmitter and receiver. The programmable loop codes' pattern content is set using the **PGM LPUP** and **PGM LPDN** commands. When **PGM CODE** is selected, the T-BERD transmits the codes when either the **LOO**p **UP** or **LOO**p **DOW**n command is turned **ON**. The alternatives are **FAC**ility **CODE**s and **CSU CODE**s.

The programmable loop codes are not used by the T-BERD's **AUTO RESPONSE** function.

EXAMPLE:

```
>PGM CODE                    :select programmable loop codes
>
```

Program Loop-Down Code

PGM LPDN :Print the programmable loop-down code
PGM LPDN (bbbbb..b) :Set programmable loop-down sequence

This command sets or returns the user-defined loop-down code sequence. The sequence is a 3 to 8 binary bit pattern (a sequence of 1's and/or 0's) with the left-most bit transmitted first. The loop-down code sequence is stored in non-volatile memory.

EXAMPLE:

```
·PGM LPDN                    :print current programmable loop-down code
>01001001
·PGM LPDN 10001000           :set programmable loop-down code to 10001000
·
```

PGM LPUP

Program Loop-Up Code

PGM LPUP :Print the programmable loop-up code
PGM LPUP (bbbbb..b) :Set programmable loop-up code sequence

This command sets or returns the user-defined loop-up code sequence. The sequence is a 3 to 8 binary bit pattern (a sequence of 1's and/or 0's) with the left-most bit transmitted first. The loop-down code sequence is stored in non-volatile memory.

EXAMPLE:

>**PGM LPUP** :print current programmable loop-up code
1001001
>**PGM LPUP 1000000** :set programmable loop-up code to 1000000

Programmable Data Pattern

PGM PAT 1 :Print the programmable data pattern 1
PGM PAT 2 :Print the programmable data pattern 2
PGMPAT(yyyyyyy,bbbb..b) :Set programmable data pattern name and bit sequence

This command sets or returns the user-defined programmable pattern. It allows the user to define the data pattern name and the pattern that is generated when the PATTERN switch is in the pgmpat-name position. The PGMPAT name is factory set to USER. This label may be changed by entering a name with a maximum of 7 alphanumeric characters. When entering the PGMPAT, specifying a name is optional. If a name is specified, it will replace pgmpat-name in the display. The pattern is a 3 to 24 binary bit pattern (a sequence of ones (1) and/or zeros (0)) with the left-most bit transmitted first. The user-defined label and pattern are stored in non-volatile memory.

EXAMPLE:

```
>PGM PAT 1                          :print current programmable pattern 1
  USER 1000
>PGM PAT 1 TESTIT,
10101110000000000111010             :select name and bit sequence
>PGM PAT 1, 11010101110000          :select bit sequence, retain previous name
```

Initiate Printout

PRI [CON / RES] :Select controls or results printout

This command causes the specified printout to be generated. The **PRI RES** and **PRI CON** commands generate results printouts and controls printouts, respectively.

EXAMPLE:

```
>PRI RES          :generate results print
.                 :results print follows
.
.
>PRI CON          :generate controls print
.                 :controls print follows
.
.
>
```

Print Event Select

PRI EVE :Print the print event status
PRI EVE (event) :Select print event

This command sets or returns the current Print Event setting. This command determines when the T-BERD will generate automatic results prints. The (**event**) choices are the following.

OFF	:Halt printouts, clear printer FIFO
ERR	:Print on logic, BPV, or frame error
SEV ERR SEC	:Print on occurrence of a severely errored second
15 M	:Print out every 15 minutes
2 HR	:Print out every 2 hours
TES END	:Print out at end of test
TIMh:mm	:Print out on time interval (maximum of 6 hours)

Any setting other than **PRI EVE OFF** will also enable automatic results printouts when one or more alarm conditions change.

EXAMPLE:

>**PRI EVE** :print status of print event
OFF
>**PRI EVE TIM 3:00** :print results print every 3 hours

Print the Single T-BERD Result Value

PRINT (result) :Print the specified result value

This command is used to print out the value of a T-BERD result. The valid result names are listed below.

ALARMED SEC	:Alarmed second
ASYN ERR SEC	:Asynchronous errored seconds
%AVLBILITY	:% Availability
BIT ERRORS	:Bit errors
BIT ERR RT	:Bit error rate
BPV RATE	:BPV rate
BPV SECONDS	:BPV seconds
CLOCK TIME	:Clock time of day
CRC ERR RT	:CRC error rate
CRC ERRORS	:CRC errors
CRC ERR SEC	:CRC errored seconds
CRC SES	:CRC severely errored seconds
CSES	:Consecutive severely errored seconds
DATE	:Date
DEGR MIN	:Degraded minutes
%DEGR MIN	:% Degraded minutes
ELAPSE TIME	:Elapsed time
ER FREE SEC	:Error-free seconds
%EFS	:% Error-free seconds
FRM ERRORS	:Frame errors
FRM ER RATE	:Frame error rate
FRM ERR SEC	:Frame errored seconds
FRM LOS CNT	:Frame loss count
FRM LOS SEC	:Frame loss seconds
FRM SES	:Frame severely errored seconds
OUT SYN SEC	:Out-of-sync seconds
RX FREQ	:Receive frequency in Hz
RX LEVEL DBM	:Receive level in dBm
RX LEVEL DSX	:Receive level in dBdsx
RX LEVEL Vp-p	:Receive level in volts
SEV ERR SEC	:Severely errored seconds
%SEV ER SEC	:% Severely errored seconds
SIG LOS SEC	:Signal loss seconds
SLIP ANA SEC	:Timing slip analysis seconds
SLIPS	:Pattern slips
SPX CURRENT	:Simplex current
SYN ERR SEC	:Synchronized error seconds
TEST END IN	:Time remaining in timed test

TEST LENGTH	:Length of a timed test
TEST SECOND	:Test seconds
TIMING SLIP	:Uncontrolled timing slips
UNAVL SEC	:Unavailable seconds
VIOLATIONS	:Violations

EXAMPLE:

```
>PRINT SLIPS          :print number of pattern slips
 23
```

Remote Control Command Prompt

PROMPT :Print status of the prompt
PROMPT [ON / OFF] :Turn prompt on or off

This command sets or returns the current prompt mode setting. It allows the user to selectively enable or disable the remote control command prompt. If the prompt is turned **ON**, a ">" character will be sent to the controller whenever the T-BERD is ready to receive another command. If the prompt is turned **OFF**, no such transaction occurs.

EXAMPLE:

>**PROMPT** :print status of prompt
ON
PROMPT OFF :note that no prompt follows

Receive Input

REC INP :Print current receive input status
REC INP [BRI / TER / DSX] :Select receive input setting

This command sets or returns the current receive input setting. It allows the user to select the input impedance and signal conditioning. The **BRI**dge position provides greater than 1000 ohms input impedance for lines already terminated. The **TER**m position provides 100 ohms impedance. The **DSX** position provides both 100 ohms impedance and amplification of the signal. This command causes a test restart.

EXAMPLE:

```
>REC INP                    :Print current receive input status
  DSX
>REC INP TER                :Select term position
>
```

Release All Printouts From a HOLD

REL

This command ends a printer hold initiated by the **HOLD** command, allowing all accumulated results to be printed.

EXAMPLE:

```
>HOLD                    :hold all printer outputs
>PRI RES                 :generate results print
>PRINT BIT ERRORS        :generate print of single result
>REL                     :release the printer hold
.                        :out come the printouts requested earlier
.
>
```

Remote Entry Control

REMOTE

This command allows the user to enter remote control without setting up the terminal mode (see **TERMINAL**). It is not necessary to use this command to get into remote mode.

EXAMPLE:

```
REMOTE          :now in remote control
                :user must enable prompt and echo
```

RES 1 and 2

Display Analysis Results

RES 1 (result #) :Display (result #) in Display I
RES 2 (result #) :Display (result #) in Display II

This command causes the T-BERD to display the selected (result #) in one of its displays. The valid result numbers are listed below. The results marked with an asterisk (*) are available only with the Performance Analysis Option.

0	Bit errors
1	Asynchronous errored seconds
4	Bit error rate
5	Error-free seconds
6	% Error-free seconds
7	Synchronized error seconds
8	Out-of-sync seconds
9	Slips
10	Severely errored seconds *
11	% Severely errored seconds *
12	Degraded minutes *
13	% Degraded minutes *
14	Unavailable seconds *
15	% Availability *
16	Consecutive severely errored seconds
25	Violations
26	BPV seconds
27	BPV rate
28	Frame errored seconds
29	Frame severely errored seconds
30	Frame errors
31	Frame error rate
32	CRC errors
33	CRC errored seconds
34	Frame loss count
35	Frame loss seconds
36	CRC severely errored seconds
37	CRC error rate
40	Receive frequency
41	Receive level dBdsx
42	Receive level dBm
43	Simplex current
44	Signal loss seconds
45	Alarmed seconds

RES 1 AND 2

46	Test length
47	Test seconds
48	Time remaining in a timed test
49	Clock time
50	Date
51	Slip analysis seconds
52	Timing slips
53	Elapsed time
54	Receive level volts

EXAMPLE:

```
>RES 1 50          :display date in Display I
>RES 2 35          :display frame loss seconds in Display II
```

Restart Test

RESTART

This command restarts the T-BERD test.

EXAMPLE:

>**RESTART** :restart test

Short Form Results Print

SHORT

This command provides the user with the short form of the results print. This is the format which includes only those available results which are specifically applicable to the current mode, plus the two results currently being displayed on the front panel. The short form contains a subset of the normal form results print. The alternative format is **NORMAL.**

EXAMPLE:

>**SHORT** :activate short form of results print

Slow Print Speed

SLOW

This command enables the slow printer speed for all printer outputs. In slow mode, no more than 20 characters per second are printed with an additional ½ second delay at the end of each printed line. The alternative is **FAST** print speed.

EXAMPLE:

```
>SLOW                    :enable slow print speed
>
```

Set Printer Line Terminator

TERM 232 :Print current line terminator
TERM 232 [CR / CRLF] :Select line terminator

This command sets or returns the RS-232 line terminator. It permits the user to select the line terminator to be used by the printer. If **CR** (carriage return) is selected, a carriage return only is transmitted at the end of each printed line. If **CRLF** (carriage return/line feed) is selected, each printed line is followed by a carriage return and a line feed.

EXAMPLE:

>**TERM 232** :print current line terminator
CRLF
>**TERM 232 CR** :select carriage return as line terminator. Note that when using a terminal, this prompt would be printed immediately on top of the previous prompt

Set the T-BERD To Talk to a Dumb Terminal

TERMINAL
. (period) :alternate form of TERMINAL command

This command configures the T-BERD to be controlled from a dumb terminal. Specifically, it sets the following modes.

ECHO ON	:Turn echo on
PROMPT ON	:Turn on command prompt
TERM 232 CRLF	:Set line terminator to CRLF

This command is typically used as a terminal log-in sequence just after the T-BERD is powered up. The user need only type a period (".") to get the T-BERD's attention and have a prompt (">") printed on the screen, verifying proper cable hookup.

EXAMPLE:	:assume that the T-BERD has just been turned on and the user types a period (".") and a RETURN, which the T-BERD will not echo
>	:the T-BERD responds with a prompt and is now in remote mode

Timing Mode Select

TIM :Print current timing mode
TIM [EXT / REC / INT] :Select timing mode

This command sets or returns the current timing mode. The T-BERD timing mode can be set to **EXT**ernal, **REC**overed, or **INT**ernal. Note that certain modes, such as Self-Test, can only operate in one mode, **INT**ernal. In such a case, the T-BERD will select that mode automatically without user intervention.

EXAMPLE:

>**TIM** :print current timing mode
>**EXT TIM MOD REC** :select recovered timing mode
>

TIM SET

Set Time for Length of Timed Test

TIM SET :Print current test length
TIM SET hhh:mm :Set test length

This command sets or displays the analysis test length. The test length may be specified in hours and minutes with a maximum of 200 hours and 59 minutes.

EXAMPLE:

```
>TIM SET                    :print the current test length
  24:00
>TIM SET 5:30               :set test length to 5 hours and 30 minutes
```

TIM TES

Enable Timed Test

TIM

This command enables the start of a timed test. The duration of the test is determined by the value of the test length. This command causes a test restart.

EXAMPLE:

>TIM TES :start a timed test

TRA OUT

Transmit Output

TRA OUT :Print current transmit output status
TRA OUT [-7.5 / 0 / -15] :Select transmit output setting

This command sets or returns the current transmit output setting. It allows the user to select emulation of three different cable losses for T1 rates. Selectable line buildout includes -7.5 dB, 0 dB, and -15 dB.

EXAMPLE:

>**TRA OUT** :print current transmit output status
-7.5 (dB)
>**TRA OUT -15** :select -15 dB position

Unformat Printouts

UNFORMAT :Select unformatted printouts

This command disables the printing of blanks in printouts. This makes it easier for the computer controller to read. The alternative is **FORMAT**, which is more desirable for the human controller. When leaving remote control and returning to local mode, printouts are automatically reset to formatted mode.

Sample Unformatted Print

```
PATTERN:3IN24
MODE:T1
13:41:5724 OCT
CONTROLSPRINT
```

EXAMPLE:

```
->UNFORMAT          :disable printing of blanks in printouts
>
```

Select Printout Screen/Paper Width

WIDTH :Print current width
WIDTH [20 / 80] :Select width

This command sets or returns the screen/printout paper width. The printout width selection determines how the results and controls prints (as well as some of the help printouts) will be printed across the screen or page. The choices are 20 or 80 characters (columns) per line.

EXAMPLE:

>**WIDTH** :print the current width
20 (COL)
>**WIDTH 80** :set to 80-column width

5.8 TIMING SLIPS DESCRIPTION

The RS-232 Printer Remote Slips Interface provides the same functions and switches found on the Printer Remote Interface, with the addition of a WECO 310 jack labeled T1-REF. This T1-REF input, used in conjunction with the RECEIVER INPUT, is used to measure uncontrolled clock slips between the two inputs. This interface enables two additional results: TIMING SLIPS AND SLP ANA SEC (slip analysis seconds).

The TIMING SLIP result is displayed in three portions: a numeric value, a bar graph, and a moving "wheel". Figure 5-3 is a diagram of the display. The numeric value may be a number ranging from 0 to 9999, and it represents the total number of frame slips (193-bit slips). The next portion of the result, the bar graph, is a graphic representation of partial frame slips. These five characters display bit slips with a resolution of 16 bits and a range of ±192 bits. When this display overflows (over +192 bits or under -192 bits), the frame slip counter is incremented, and the bar graph display is reset to zero (center point). The wheel is a 16-position display arranged in a circle. The wheel is used in conjunction with the bar graph to graphically display the direction, velocity, and magnitude of timing slips. Figure 5-34 shows the values assigned to each position of the bar graph and the wheel.

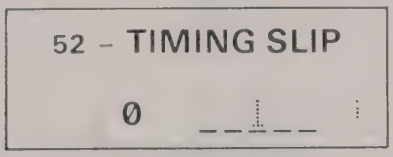
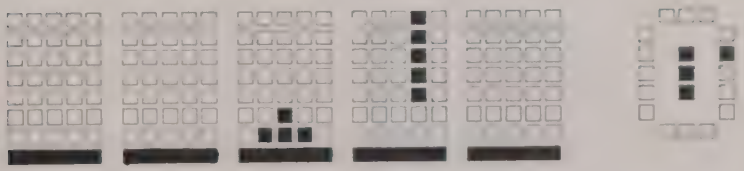


Figure 5-3
Timing Slips Result Display

The magnitude of a timing slip is determined by adding the magnitude of the number indicated by the wheel's position to the corresponding bar graph value. For example, if the display shows:



the bar graph value is +96 and the wheel value is +3, adding these two values results in a timing slip of +99 bits (that is, 99 more clock cycles have been

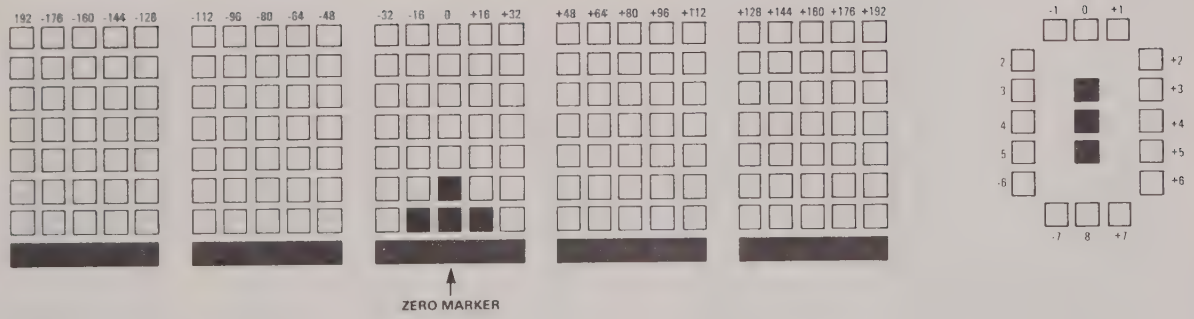
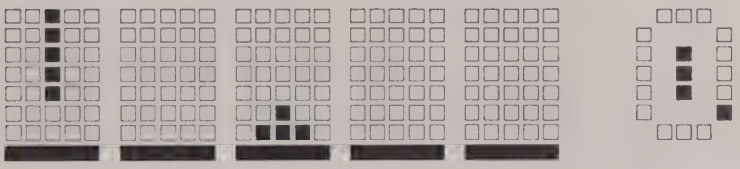


Figure 5-4
Bar Graph and Wheel Values

received at the RECEIVE input than at the T1 REF input, or the RECEIVE input is receiving a higher frequency than the T1 REF input). If the display shows:



the bar graph value is -160 and the wheel value is +6, resulting in a timing slip of -154 bits.

The SLP ANA SEC result represents the total number of seconds in which both the T1-REF and RECEIVE inputs have been present and available for timing slips analysis.

SECTION 6
MAINTENANCE AND SERVICE

6.1 INTRODUCTION

This section contains information on maintenance and service for the T-BERD 209 T-Carrier Analyzer. Specifically, it includes steps to take should the user experience difficulty operating the T-BERD 209, information on replacing the AC line fuse, and a description of TTC's warranty and repair procedures.

6.2 MAINTENANCE

6.2.1 In Case of Difficulty

If the T-BERD 209 fails to operate and no front panel indicators are illuminated, check that the AC power cord is securely connected to the T-BERD and that the power supply is uninterrupted. Also verify that a proper, working AC line fuse is installed. Information on the type of fuse and its installation is given in Section 6.2.2.

If the AC power cord, power supply, and fuse are found to be in proper working order, but the instrument fails to operate, contact the TTC Customer Service Department. If front panel indicators are illuminated, but the instrument does not appear to operate properly, use the Instrument Checkout Procedure in Section 3 as an aid to localizing the problem. If the T-BERD 209 still cannot be made to operate properly, note those areas in which the self-test failed and contact TTC for assistance.

6.2.2 AC Line Fuse

The T-BERD 209 AC receptacle contains the fuse. If faulty, the fuse should be replaced with a 500 mA, 250 volt, slow-blow fuse (Littelfuse #218.500 or equivalent). Always use the correct fuse size. To replace the fuse, use the following procedure.

(1) Locate the plastic fuse holder above the AC receptacle.

(2) Using a screwdriver or similar instrument, gently pry the fuse holder out of the power cord.

NOTE: When shipped from the factory, the fuse holder contains a spare AC line fuse.

(3) Remove the old fuse and install new fuse of the correct size.

(4) Press the plastic fuse holder securely back into place above the AC receptacle.

6.2.3 Ground Jumper

The T-BERD 209 chassis ground is connected to circuit ground via a 100-ohm, ½ watt resistor. A jumper is provided which allows direct connection of circuit ground to chassis ground. To access the jumper, use the following procedure.

(1) Remove power from the T-BERD 209.

(2) Depending on how your T-BERD 209 is equipped, remove the Printer Interface module, the Printer/Remote Control Interface module, or the blankoff plate from the front panel of the T-BERD.

(3) Locate pluggable jumper JW1 above and to the right of the edge connector.

(4) Using a pair of needle-nose plyers, lift the jumper from position A and press in place in position B. This connects circuit ground directly to chassis ground.

(5) Replace the interface module or blankoff plate on the T-BERD front panel.

6.3 SERVICE

6.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable unless express written authorization of the warranty transfer is granted by TTC.

The T-BERD 209 T-Carrier Analyzer will be repaired or replaced (at our option) at no charge for a period of one (1) year after original receipt by the customer. An optional warranty for three (3) years is available for purchase; contact TTC for further information on this extended warranty. Liability under either

warranty extends only to the replacement value of the equipment. Both warranties are void under the following conditions.

(1) Equipment has been altered or repaired without specific authorization from TTC.

(2) Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

6.3.2 In-Warranty Service

Equipment in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with instructions in Section 6.3.4 of this manual. Before returning any equipment, the customer must obtain a Return Authorization (RA) number by contacting the TTC Customer Service Department. The RA number should then appear on all paperwork and be clearly marked on the outside of the equipment container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and returned to the customer with shipping prepaid. A brief description of the work performed and the materials used will be provided on the Equipment Repair Report furnished with the returned equipment.

6.3.3 Out-of-Warranty Service

The procedure for repairing out-of-warranty equipment is the same as that used for equipment still in warranty. However, there is a minimum charge of $75.00 applied to each request for out of-warranty service. The $75.00 minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. The customer will be billed for parts plus standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work can be started, and a hard copy of the purchase order must be received by TTC before the repaired equipment may be shipped to the customer. A description of the labor and materials used will be provided in the Equipment Repair Report.

6.3.4 Equipment Return Instructions

To all equipment returned for repair, the customer should attach a tag that includes the following information.

(1) Owner's name and address.

(2) A list of the equipment being returned and the applicable serial number(s).

(3) A detailed description of the problem or service requested.

(4) The name and telephone number of the person to contact regarding questions about the repair.

(5) The Return Authorization (RA) number.

If possible, the customer should return the equipment using the original shipping container and material. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. TTC is not liable for any damage that may occur during shipping. The customer should clearly mark the TTC-issued RA number of the outside of the package and ship it prepaid and insured to TTC.

SECTION 7
SPECIFICATIONS

7.1 INTRODUCTION

This section contains the specifications for the T-BERD 209 T-Carrier Analyzer.

7.2 GENERAL SPECIFICATIONS

7.2.1 Physical

- Size: 6"H x 13.5"W x 4.5"D (15.3 cm x 34.4 cm x 11.4 cm) including cover.
- Weight: 9.7 pounds (4.4 kg).

7.2.2 Operational

- Operating Temperature Range: 32°F to 122°F (0°C to 50°C).
- Storage Temperature Range: -4°F to 158°F (-20°C to 70°C).
- Power: 115 VAC ±10%, 60 Hz.
- Fuse: 500 mA, 250V Metric (5mm X 20mm) Slow-blow; Littlefuse #218.500 or equivalent.

7.3 INPUT SPECIFICATIONS

- Input Connectors: WECO 310 jack, bantam jack, and 15-pin network interface D connector.
- Input Frequency: T1 — 1544000 Hz ± 5000 Hz; T1C — 3152000 Hz ± 5000 Hz.
- Input Impedance: BRIDGE—1000 ohms or greater.
  TERM—100 ohms ±5%.
  DSX-MON—100 ohms ±5%.
- Operating Range: BRIDGE — +6 dBdsx to -24 dBdsx for T1, +6 dBdsx to -6 dBdsx for T1C. Automatic line buildout compensates for cable loss characteristics.
  TERM— +6 dBdsx to -24 dBdsx for T1, +6 dBdsx to -6 dBdsx for T1C. Automatic line buildout compensates for cable loss characteristics.
  DSX-MON— +6 dBdsx to -24 dBdsx for T1 or T1C. No automatic line buildout provided; flat loss compensation only.

7.4 OUTPUT SPECIFICATIONS

- Output Connectors: Selectable line buildout in T1 of 0 dB, -7.5 dB, and -15 dB is provided on WECO 310 jack, bantam jack, and 15-pin network interface D connector. Three additional DSX-level 310 jack outputs are provided.
- Output Line Buildout Tolerance: ±1 dB attenuation at 772 kHz.
- Pulse Shape: With output terminated in 100 ohm resistive load and 0 dB line buildout selected, the T-BERD 209 meets pulse shape specifications given in CCITT Recommendation G.703; Bell Publications CB113, CB119, CB132, CB143, and PUB62508; and AT&T PUB62411.
- Internal Oscillator Accuracy: ±5 ppm.
- Jitter Attenuation: Per Figure A-2 of AT&T PUB62411, October 1985 Revision.
- Line Codes: Bipolar (pseudoternary); switch-selectable AMI or B8ZS.

7.5 FRONT PANEL

7.5.1 Front Panel Switches

- Modes: T1, T1 D4, T1 ESF, T1 SLC, T1C, T1C TLB, T1 TLB, T1 LLB, SELF TST, AUX.
- Patterns: Fixed -ALL ONES, 1:1, 1:7, 3 IN 24, user-programmable 3-to 24-bit repeating pattern.
  Pseudorandom—T1-QRSS, 2^{15}-1, T1C-QRSS, 2^{20}-1, 2^{23}-1.
- Results: LOGIC—Bit errors, asynchronous errored seconds, bit error rate, error-free seconds, percent error-free seconds, synchronized errored seconds, out-of sync seconds, and pattern slips.
  BPV & FRAME—Violations, BPV seconds, BPV rate, frame errors, frame error rate, CRC errors, CRC errored seconds, CRC severely errored seconds, frame loss count, frame loss seconds, frame errored seconds, frame severely errored seconds.
  SIGNAL & TIME—Received frequency, received level (dBm), received level (dBdsx), simplex current, signal loss seconds, alarmed seconds, test length, test seconds, seconds until test end, elapsed time, clock time (with Printer Interface option), date (with Printer Interface option), and timing slips and slip analysis seconds (with Printer/Remote/Slips Interface Option).
  Performance Analysis Option—Severely errored seconds, percent severely errored seconds, degraded minutes, percent degraded minutes, unavailable seconds, percent availability, consecutive severely errored seconds.
- Test Lengths: Timed or continuous.
- Timed Test Length: 1 minute to 200 hours, 59 minutes, in 15-second intervals. Factory setting is 15 minutes.
- Transmit Timing Selection: External, internal, recovered.
- Transmit Codes: AMI, B8ZS.

- Error Insert: BPV—single or constant 10^{-6} rate.
  Logic—single or constant 10^{-6} rate.
- Receive Input: Bridge, Terminate, DSX-Monitor.
- Transmit Output Level: 0 dB, -7.5 dB, -15 dB.

7.5.2 Indicators

- Alarm Indicators: Signal Loss, Signal Loss History, Pattern Loss, Pattern Loss History, Frame Loss, Frame Loss History, Excess Zeros, Excess Zeros History, Yellow Alarm, Yellow Alarm History, All Ones, All Ones History, Power Loss History.
- Loop Code Indicators: Loop Up Detect, Loop Down Detect, TLB Detect, LLB Detect, Pre-Existing Loop, Loop Up Send, Loop Down Send.
- Error Insert Indicators: BPV Error Insert, Logic Error Insert.
- Status Indicators: T1 Pulses, T1C Pulses, Pattern Sync, B8ZS Detect, Display Hold.

7.5.3 Alarm Criteria.

- Signal Loss: 150 milliseconds without input pulses after valid frequency and level are detected.
- Pattern Sync Loss: 250 errors detected in 1000 or fewer bits.
- Frame Sync Loss: D4—2 out of 5 Ft bits in error.
  ESF—2 out of 5 frame bits in error.
  SLC—2 out of 5 Ft bits in error.
- Excess Zeros: 16 consecutive zeros in T1; 34 consecutive zeros in T1C.
- Yellow Alarm: D4—Bit 2 is a 0 for 255 consecutive channels.
  ESF—256 bits ±16 bits of a repetitive "1111111100000000" pattern received.
  SLC—Bit 2 is a 0 for 255 consecutive channels.
- All Ones: 1024 consecutive ones (1's) in unframed T1 or T1C signals; 128 consecutive ones (1's) for T1 framed modes.

7.6 PATTERN SPECIFICATIONS

7.6.1 Pattern Definition.

- ALL ONES: All Marks.
- 1:1 Alternating Mark and Space.
- 1:7 :One Mark and seven Spaces.
- 3 IN 24: 1000 1000 1000 0000 0000 0000.
- T1-QRSS: QRSS pattern (2^{20}-1 with zero suppression)
- 2^{15}-1: 2^{15}-1 bit pseudorandom.
- 2^{20}-1 and T1C-QRSS: 2^{20}-1 bit pseudorandom.
- 2^{23}-1: 2^{23}-1 bit pseudorandom.
- pgmpat-name: User defined pattern, factory setting is USER for a 1:3 pattern

7.6.2 Pattern Sync Detection Criteria

- Fixed Patterns: 30 consecutive error-free bits.
- Pseudorandom Patterns: 30 ± n consecutive error-free bits for a pattern length of 2^n-1. For QRSS, n = 20.

7.7 LOOP CODES

7.7.1 Generation Patterns

The generated codes may be sent unframed or, when framing is selected, they may be sent either embedded between the framing bits or overwritten by the framing bits.

- CSU Loop Codes:Loop Up—repetitive "10000". Loop Down—repetitive "100."
- Facility Loop Codes:Loop Up—repetitive "1100". Loop Down—repetitive "1110".
- Programmable: 3- to 8-bit repeating code independently settable for Loop Up and Loop Down.

7.7.2 Loop Detect Criteria

- Loop Up (CSU): DIP Switch 9 must be in the up (CSU) position and at least 187 error-free bits of a repetitive "10000" pattern must be received.
- Loop Down (CSU): DIP Switch 9 must be in the up (CSU) position and at least 185 error-free bits of a repetitive "100" pattern must be received.
- Loop Up (FACILITY): DIP Switch 9 must be in the down (FACILITY) position and at least 186 error-free bits of a repetitive "1100" pattern must be received.
- Loop Down (FACILITY): DIP Switch 9 must be in the down (FACILITY) position and at least 186 error-free bits of a repetitive "1110" pattern must be received.
- TLB: The voltage on Pin 8 of the 15-pin network interface D connector is positive with respect to Pin 7 and 15 mA or more current is detected between Pins 7 and 8.
- LLB: The voltage on Pin 7 or the 15-pin network interface D connector is positive with respect to Pin 8 and 15 mA or more current is detected between Pins 7 and 8.

7.8 MEASUREMENTS

7.8.1 Frequency

- Accuracy: ±5 ppm.
- Resolution: 1 Hz.
- T1 Range: 1544000 Hz ± 5000 Hz.
- T1C Range: 3152000 Hz ± 5000 Hz.

7.8.2 Level

The designation dBdsx is a voltage measurement; a 3-volt base-to-peak signal is defined as 0 dBdsx. Measurements for dBm are available only when all ones is detected.

- dBdsx Level Range: +6 dBdsx to -35 dBdsx.
- dBdsx Level Accuracy: ±1 dB between +6 dBdsx and -10 Bdsx; ±2 dB between -10 dBdsx and -20 dBdsx; ±3 dB between -20 dBdsx and -35 dBdsx.
- dBdsx Resolution: 1 dB.
- dBm Level Range: ±23 dBm to -19 dBm.
- dBm Level Accuracy: ±1 dB between +23 dBm and +7 dBm; ±2 dB between +7 dBm and -3 dBm; ±3 dB between -3 dBm and -19 dBm.
- dBm Resolution: 1dB.
- Vp-p: This result is a voltage conversion of the dBdsx result.

7.8.3 Simplex Current

- Range: 10 mA to 180 mA.
- Resolution: 1 mA.
- Accuracy: ±5%.
- Simplex Voltage Drop: 8.5 volts (nominal) at 60 mA.

7.9 CONNECTORS

7.9.1 External BNC

- Input Configuration: AC coupled. Outer conductor is signal ground; inner conductor is signal.
- AC Input Impedance: 50 ohms ±10 %.
- Sine-Wave Clock Waveform: 7 volts peak-to-peak minimum; 20 volts peak-to-peak maximum; 1.0 MHz minimum; 50% ±2% duty cycle.
- Square-wave Clock Waveform: 1 volt peak-to-peak minimum; 20 volts peak-to-peak maximum; 1.0 MHz minimum; 50% ±2% duty cycle.

7.9.2 Front Panel 15-Pin D

- Connector Pin Configuration: See Table 7-1.

7.9.3 Optional RS-232

- Connector Pin Configuration: See Table 7-2.
- Character Format: 7 data bits (ASCII coding). Even, odd, or no parity. 2 transmitted stop bits. Accepts 1 or more received stop bits.
- Baud Rates: 300, 1200, 2400, 4800.
- Terminator: CR, CRLF.

Table 7-1
Front Panel Connector Pin Configuration

Pin Number	Name
1	TRANSMIT TIP
2, 4, 12	SIGNAL GROUND
3	RECEIVE TIP
5	NO CONNECTION
6	NO CONNECTION
7, 8	TLB, LLB DETECT
9	TRANSMIT RING
10	NO CONNECTION
11	RECEIVE RING
13	RESERVED FOR FUTURE USE
14	RESERVED FOR FUTURE USE

Table 7-2
RS-232 Pin Configuration

PROT GND (Pin 1):	Connected to chassis ground.
TX DATA (Pin 2):	The T-BERD 209 receives data on this lead.
RCV DATA (Pin 3):	Data is transmitted by the T-BERD 209 on this lead.
RTS (Pin 4):	This lead is terminated by the T-BERD 209.
CTS (Pin 5):	This lead is driven to the ON state by the T-BERD 209 whenever it is ready to receive a command. This lead may be ignored by the controller if, before issuing commands, it waits for the return of a prompt character from the T-BERD signifying the completion of the previous command.
DSR (Pin 6):	This lead is driven to the ON state by the T-BERD 209 whenever it has power applied.
SIGNAL GROUND (Pin 7):	Connected to signal ground.
RLSD (Pin 8):	This lead is driven to the ON state by the T-BERD 209 whenever it has power applied.
SEC CTS (Pin 13) and SEC RCV DATA (Pin 16):	These leads provide +12 (RS-232 ON) and -12 (RS-232 OFF) respectively, for use in strapping signaling leads ON and OFF.
DTR (Pin 20):	Data is output from the T-BERD 209 only when this line is held in the ON condition by the receiving device.

- Print Width: 20-column, 80-column.
- Connector Configuration: DCE.
- Connector: 25 pin female D-subminiature.

7.10 GROUNDING

- Chassis and signal grounds isolated by 100 ohm, ½ watt resistor.
- Bantam and 310 jack sleeves connected to chassis ground.
- Power cord center ground pin connected to chassis ground.
- 25-pin D connector: Pin 1 to chassis ground. Pin 7 to signal ground.
- 15-pin D connector: Pins 2, 4, and 12 to signal ground.

7.11 OPTIONAL TIMING SLIPS

7.11.1 Optional Timing Slips Input

- Input Connector: WECO 310 jack.
- Input Frequency: T1-1544000 Hz ± 1000 Hz.
- Input Impedance: 100 ohms ± 5%
- Operating Range: +6 dBdsx to -24 dBdsx.
- Attenuation Type: Resistive.

7.11.2 Optional Timing Slips Results

- Timing Slip Resolution: 1 frame slip.
- Timing Slip Range: 9999 frame slips.
- Bar Graph Resolution: 16 bit slips.
- Bar Graph Range: ± 192 bit slips.
- Wheel Resolution: 1 bit slip.
- Wheel Range: 16 bit slips.
- Timing Slip Printout Resolution: 1 frame slip.
- Timing Slip Printout Range: 9999 frame slips.
- Bit Slip Printout Resolution: 1 bit slip.
- Bit Slip Printout Range: ± 192 bit slips.
- Slip Analysis Seconds Resolution: 1 second.
- Slip Analysis Seconds Range: 99999999 seconds.

SECTION 8
OPTIONS AND ACCESSORIES

8.1 INTRODUCTION

This section describes the various options and accessories that are available for use with the T-BERD 209.

8.2 OPTIONS

8.2.1 Performance Analysis Option

The Performance Analysis option (Option 001) is a factory-installed package which offers the user the following additional analysis results (based on specifications contained in CCITT Recommendation G.821): percent availability, unavailable seconds, degraded minutes, percent degraded minutes, severely errored seconds, and percent severely errored seconds. These results are discussed in more detail in the following paragraphs. Appendix A provides a general discussion of the CCITT specifications.

The Performance Analysis option splits total test time into two parts: (1) time for which the connection is deemed available, and (2) time for which the connection is deemed unavailable. When a test starts, it is considered to be available time. This period of available time terminates when the bit error rate (BER) in each second is worse than 1×10^{-3} for a period of 10 consecutive seconds. These 10 consecutive seconds are then considered to be unavailable time. During available time, the detection of the tenth consecutive severely errored second causes the count of unavailable seconds to be incremented by 10 and the number of available seconds to be decremented by 10. The period of unavailable time continues until 10 consecutive seconds with a BER better than 1×10^{-3} are detected. These 10 seconds are then considered to be a part of available time. Upon the detection of the tenth consecutive second with a BER better than 1×10^{-3}, the number of available seconds would increment by 10 and the unavailable seconds count would decrement by 10. A signal loss second and a pattern synchronization loss second are each considered to be a second with a BER worse than 1×10^{-3}.

The percent availability result is the ratio, expressed as a percentage, of the number of available seconds to the number of total test seconds. Available seconds are measured in the same manner as for the unavailable seconds result. Percent availability decreases when a period of unavailable time begins. If no unavailable seconds are counted during a test, the percent availability is "100.00%." If all test seconds are unavailable seconds, the result is "0.00%." Once unavailable seconds have been detected, the highest value that percent availability can have is "99.99%." At the other end of the scale, if at least 1 available second is counted, the minimum value is "00.01%." For all values of percent availability, the result format is "XX.YY%."

The degraded minutes result is the number of minutes during which the bit error rate is worse than 1 x 10^{-6}. The 1-minute intervals are derived by removing unavailable seconds and severely errored seconds from the total test time and then consecutively grouping the remaining seconds into blocks of 60.

The percent degraded minutes result is the ratio, expressed as a percentage, of degraded minutes to the number of available minutes. If no degraded minute is counted during a test, the percent degraded minutes is "0.00%". If all test minutes are degraded minutes, the result is "100.00%". Once a non-degraded minute has been detected, the highest value percent degraded minutes can have is " > 99.99%". At the other end of the scale, if at least 1 degraded minute is counted, the minimum value is " < 0.01%". For all values of percent degraded minutes, the result format is "XX.YY%".

The severely errored seconds result is the count of the number of seconds during which a bit error rate worse than 1 x 10^{-3} occurs within the available time. Signal loss seconds and pattern synchronization loss seconds are considered as seconds with a bit error rate worse than 1 x 10^{-3}. When unavailable time is declared, 10 seconds are subtracted from the severely errored seconds count.

The percent severely errored seconds result is the ratio, expressed as a percentage, of severely errored seconds to the number of available seconds. If no severely errored seconds are counted during a test, the percent severely errored seconds is "0.00%". If all test seconds are severely errored seconds, the result is "100.00%". Once a non-severely errored second has been detected, the highest value that percent severely errored seconds can have is " > 99.99%". At the other end of the scale, if at least 1 severely errored second is counted, the minimum value is " < 0.00%". For all values of percent severely errored seconds, the result format is "XX.YY%".

8.2.2 RS-232 Printer Interface Option (Model 30505-02)

The optional RS-232 Printer Control Interface installs in the front of the T-BERD 209 and allows the T-BERD to be connected to printers. This option is described in detail in Section 5.

8.2.3 RS-232 Printer/Remote Control Interface Option (Model 30505-01)

The optional RS-232 Printer Remote Control Interface installs in the front of the T-BERD 209 and allows the T-BERD to be connected to printers, controllers, or terminals which have an RS-232 interface. This option is described in detail in Section 5.

8.2.4 RS-232 Printer/Remote/Slips Interface Option (Model 30554)

The optional RS-232 Printer Remote Slips Interface installs in the front of the T-BERD 209 and allows the T-BERD to be connected to printers, controllers, or terminals which have an RS-232 interface. The interface additionally features timing slip analysis capabilities. This option is described in detail in Section 5.

8.3 ACCESSORIES

Various accessories are offered for use with the T-BERD 209; these accessories are described in the following paragraphs. Contact TTC's Customer Service Department for ordering information.

8.3.1 Rack Mount (Model 10685)

The Rack Mount allows the T-BERD 209 to be mounted in a standard 19" equipment rack. The assembly requires 7" of vertical rack space. To install the T-BERD 209 in the rack mount, use the following procedure.

(1) Loosen but do not remove the four #6 screws that secure the rack mount's rear bracket to the rack mount tray. Slide the rear bracket to the back of the rack mount tray.

(2) Remove the T-BERD 209's cover. It is not necessary to remove the T-BERD's feet or handles.

(3) Lower the T-BERD through the top of the rack mount until it sits on the rack mount tray. Slide the T-BERD forward so that its front panel (including the handles) protrudes through the opening in the front of the rack mount. The strikes on the sides of the T-BERD will prevent it from being pulled through the opening. Ensure that the pull-out reference card is accessible and that it may be hinged down over the edge of the rack mount.

(4) Once the T-BERD is properly seated in the rack mount, slide the rack mount's rear bracket firmly against the T-BERD so that the T-BERD's four rear feet protrude through the designated holes in the bracket.

(5) Tighten the four #6 screws that were loosened in Step 1 to secure the T-BERD 209 in the rack mount.

8.3.2 Cables

The following is a list of the accessory cables that are available from TTC for use with the T-BERD 209.

Model	Description
10199	15-pin D to 15-pin D (10')
10420	310 plug to 310 plug (10')
10558	310 plug to alligator clips (10')
10559	310 plug to bantam plug (10')
10615	Bantam plug to bantam plug (10')
10648	Bantam plug to alligator clips (10')
10686	15-pin D to RJ45 (10')
40606	15-pin D to RJ48 (10')

APPENDIX A
DISCUSSION OF G.821

This appendix discusses the concept of available time versus unavailable time as specified in CCITT Recommendation G.821. This discussion is provided to familiarize users with the results that may be obtained with the optional Performance Analysis Package.

CCITT Recommendation G.821 defines available and unavailable time as follows:

> "A period of unavailable time begins when the bit error rate (BER) in each second is worse than 10^{-3} for a period of 10 consecutive seconds. These 10 seconds are considered to be unavailable time. The period of unavailable time terminates when the BER in each second is better than 10^{-3} for a period of 10 consecutive seconds. These 10 seconds are considered to be available time."

Available and unavailable time are measured in seconds—available seconds and unavailable seconds, respectively. All test seconds must fall into one of the two categories (total available seconds + total unavailable seconds = total test seconds).

At the beginning of a test, test seconds are considered to be available time; the available seconds begin counting. These seconds continue to be counted until 10 consecutive seconds occur each with a BER worse than 10^{-3}. A sliding window, 10 seconds in length, is used to detect this transition from available to unavailable time and vice versa.

As an example, assume a test begins and continues to run for 25 seconds and each of those 25 seconds has a BER better than or equal to 10^{-3}. When the test starts, test seconds are considered to be available time, so the available seconds count at this point is 25. In the 26th second, the BER becomes worse than 10^{-3}. The same for the 27th and 28th seconds. In the 29th second, the BER drops back to better than or equal to 10^{-3}. All 29 seconds are a part of available time and are, therefore, counted as available seconds.

sec 20	sec 21	sec 22	sec 23	sec 24	sec 25	sec 26	sec 27	sec 28	sec 29
BER <=	BER <=	BER <=	BER <=	BER <=	BER <=	BER >	BER >	BER >	BER <=

Sliding Window After 29th Test Second Still in Available Time

Even though there were 3 consecutive seconds (the 26th, 27th, and 28th) which each had a BER worse than 10^{-3}, 10 such consecutive seconds are required to make the transition to unavailable time. Those 3 individual seconds are still in available time and they are counted as available seconds.

The 3 seconds with a BER worse than 10^{-3} are also included in the count of severely errored seconds, which are those test seconds with a BER worse than 10^{-3} that occur in available time. A signal loss second or a second in which pattern synchronization is lost is also considered to be a second with a BER worse than 10^{-3}. Therefore, the current test result values for available seconds count = 29; the severely errored seconds (SES) count = 3, and the unavailable seconds count = 0.

The same test continues to run and remains in available time. In the 80th second, the BER for that second is worse than 10^{-3}. The BER for the 81st, 82nd, 83rd, 84th, and 85th seconds is also worse than 10^{-3}. In the 86th second, pattern synchronization is lost. This also continues for the 87th and 88th seconds. We now have 9 consecutive seconds each of which has a BER worse than 10^{-3}. As each of these test seconds occurs, we are still in available time, so they are counted as available seconds and severely errored seconds. The transition has not been made from available time to unavailable time.

sec 79 BER <=	sec 80 BER >	sec 81 BER >	sec 82 BER >	sec 83 BER >	sec 84 BER >	sec 85 BER >	sec 86 BER >	sec 87 BER >	sec 88 BER >

Sliding Window After 88th Test Second
Still in Available Time

The 89th test second also has a BER worse than 10^{-3}. At this point, the available seconds count = 89, the SES count = 13, and the unavailable seconds count = 0. However, the sliding window now contains 10 consecutive seconds each of which has a BER worse than 10^{-3}. A transition is made to unavailable time.

sec 80 BER >	sec 81 BER >	sec 82 BER >	sec 83 BER >	sec 84 BER >	sec 85 BER >	sec 86 BER >	sec 87 BER >	sec 88 BER >	sec 89 BER >

Sliding Window After 89th Test Second
Transition to Unavailable Time

Those 10 seconds which had been counted as available seconds are deducted from the available seconds count and are added to the unavailable seconds count; the available seconds count becomes 79, and the unavailable seconds count become 10. Those same 10 seconds were also included in the SES count. However, SES is limited to only those seconds in available time which have a BER worse than 10^{-3}; therefore, those last consecutive 10 seconds must also be deducted from the SES count (the SES count is updated to 3).

Once the transition occurs from available time to unavailable time, all test seconds are counted as unavailable seconds until 10 consecutive seconds occur each with a BER better than 10^{-3}. As the sample test continues, the 90th through 150th seconds each have a BER worse than or equal to 10^{-3}. We are still in unavailable time, so these seconds are counted as unavailable seconds; now the total available seconds count = 79 and the total unavailable seconds count = 71.

Beginning with the 151st second, the BER for that second falls below 10^{-3}. It is still counted as an unavailable second since we are still in unavailable time and the transition has not been made to available time. A BER better than 10^{-3} also occurs for the 152nd, 153rd, 154th, 155th, 156th, 157th, 158th, 159th, and 160th seconds. Since there are now 10 consecutive seconds with a BER better than 10^{-3}, the transition is made from unavailable time to available time.

sec 151 BER <	sec 152 BER <	sec 153 BER <	sec 154 BER <	sec 155 BER <	sec 156 BER <	sec 157 BER <	sec 158 BER <	sec 159 BER <	sec 160 BER <

Sliding Window After 160th Test Second
Transition to Available Time

As each of these 10 seconds occurred, it was added to the unavailable seconds count (unavailable seconds = 81, available seconds = 79, and SES = 3). Now that those consecutive seconds have triggered the transition to available time, they are deducted from the unavailable seconds count and added to the available seconds count. Now the unavailable seconds count = 71 and the available seconds count = 89.

The monitoring of available and unavailable time continues for the duration of the test.

Degraded minutes is an error analysis result that is affected by available and unavailable time. Degraded minutes is a count of the number of minutes during which an average BER worse than 10^{-6} occurs. The 1 minute intervals are derived by removing unavailable seconds and severely errored seconds (SES) from the total test time and then consecutively grouping the remaining seconds into blocks of 60. The average BER is calculated for the block of 60 seconds and if it is worse than 10^{-6}, the block is counted as a degraded minute.

In the transition from available time to unavailable time, the degraded minutes result is unaffected. This is because a switch to unavailable time requires 10 consecutive seconds each with a BER worse than 10^{-3}. Any second in available time with a BER worse than 10^{-3} is considered to be a severely errored second and, therefore, not included in the accumulation of seconds used to calculate degraded minutes.

Moving from unavailable time to available time may affect the degraded minutes count. While in unavailable time, 10 consecutive seconds each with a BER better than 10^{-3} are required for the transition to available time. When this happens, those 10 seconds are subtracted from the unavailable seconds count and are added to the available seconds count. Since these seconds are now considered to be a part of available time and they are not severely errored seconds, they are included in the calculation of degraded minutes.

The degraded minutes result is the number of minutes during which the bit error rate is worse than 1×10^{-6}. The 1-minute intervals are derived by removing unavailable seconds and severely errored seconds from the total test time and then consecutively grouping the remaining seconds into blocks of 60.

The percent degraded minutes result is the ratio, expressed as a percentage, of degraded minutes to the number of available minutes. If no degraded minute is counted during a test, the percent degraded minutes is "0.00%". If all test minutes are degraded minutes, the result is "100.00%". Once a non-degraded minute has been detected, the highest value percent degraded minutes can have is " > 99.99%". At the other end of the scale, if at least 1 degraded minute is counted, the minimum value is " < 0.01%". For all values of percent degraded minutes, the result format is "XX.YY%".

The severely errored seconds result is the count of the number of seconds during which a bit error rate worse than 1×10^{-3} occurs within the available time. Signal loss seconds and pattern synchronization loss seconds are considered as seconds with a bit error rate worse than 1×10^{-3}. When unavailable time is declared, 10 seconds are subtracted from the severely errored seconds count.

The percent severely errored seconds result is the ratio, expressed as a percentage, of severely errored seconds to the number of available seconds. If no severely errored seconds are counted during a test, the percent severely errored seconds is "0.00%". If all test seconds are severely errored seconds, the result is "100.00%". Once a non-severely errored second has been detected, the highest value that percent severely errored seconds can have is " > 99.99%". At the other end of the scale, if at least 1 severely errored second is counted, the minimum value is " < 0.00%". For all values of percent severely errored seconds, the result format is "XX.YY%".

APPENDIX B
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